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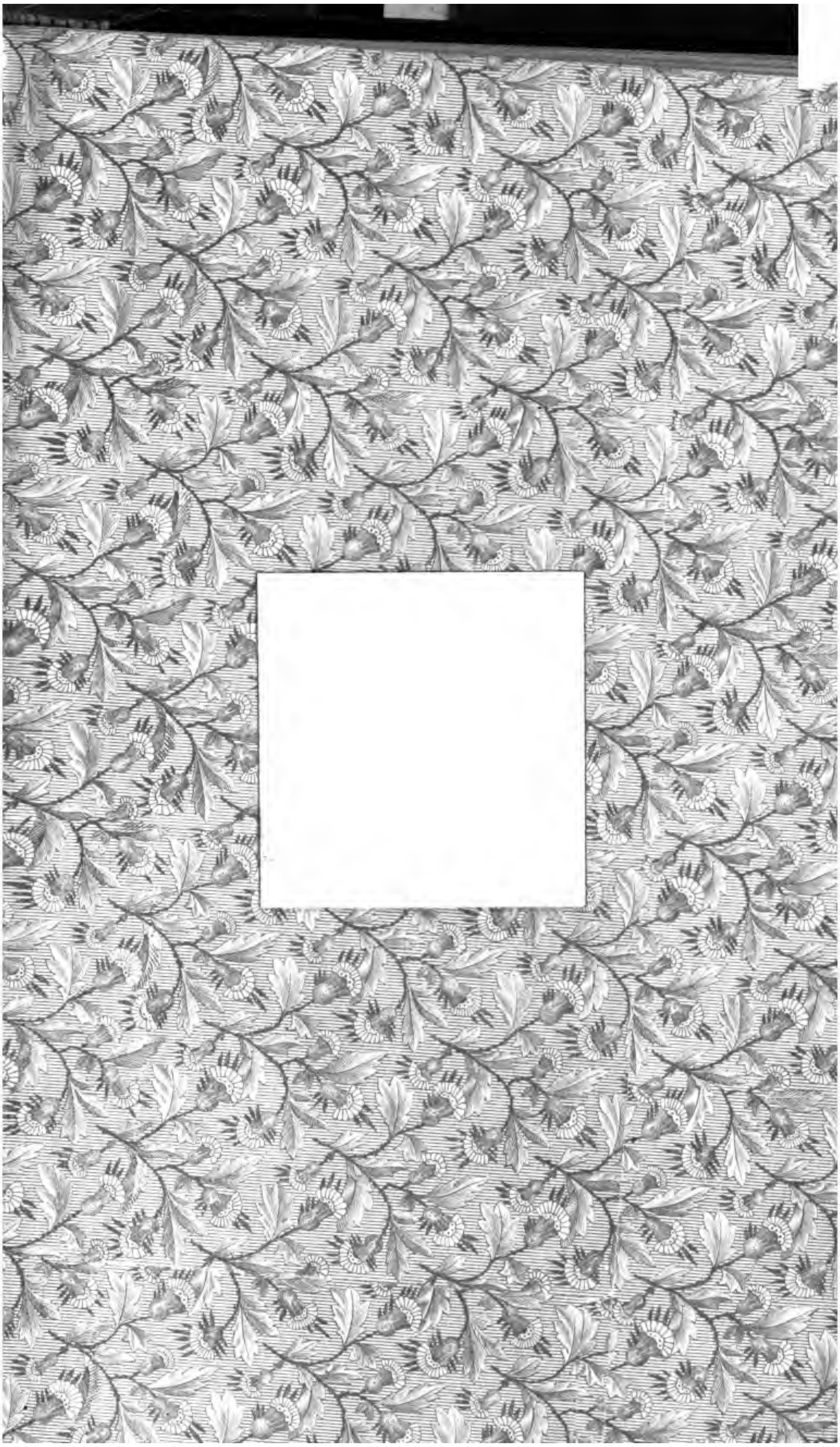

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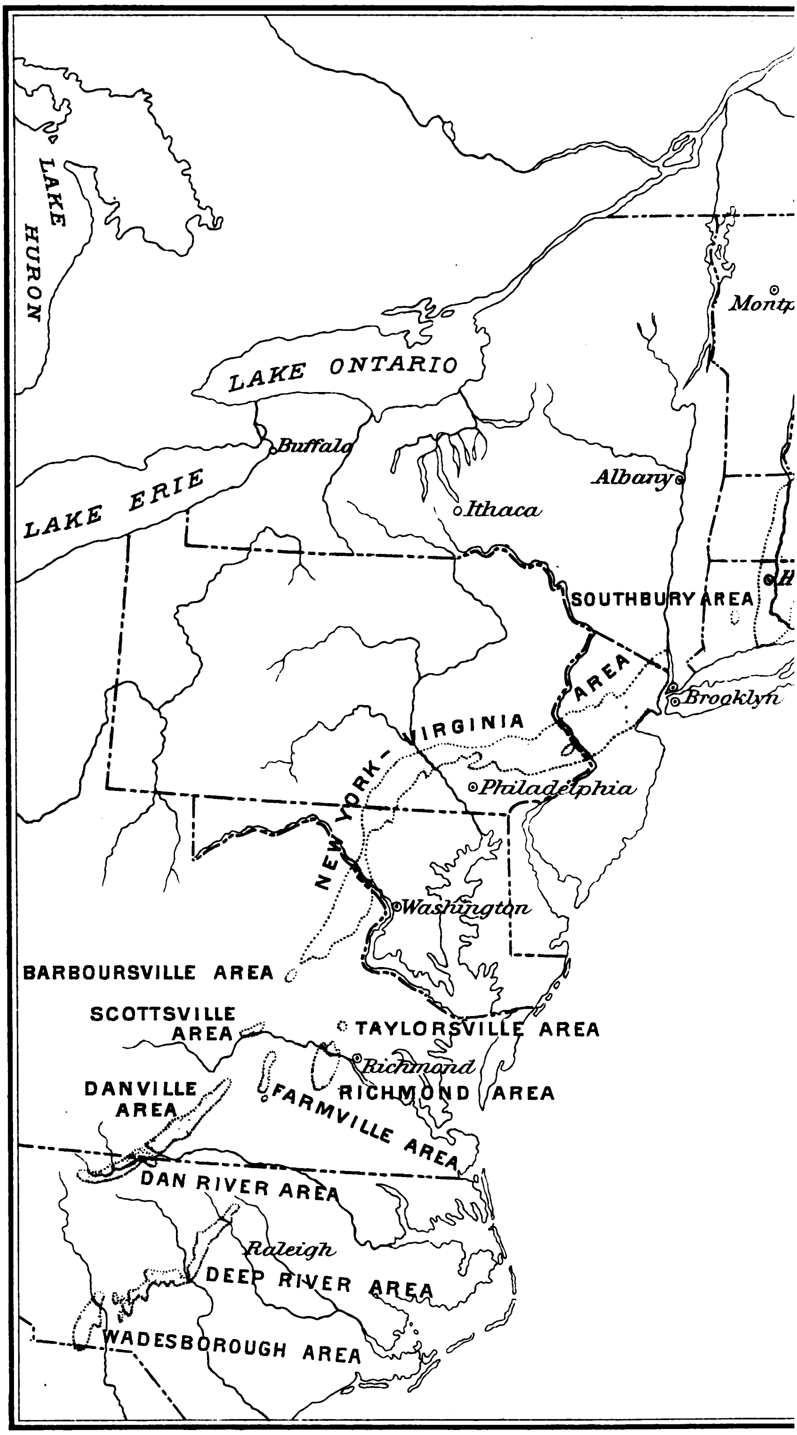
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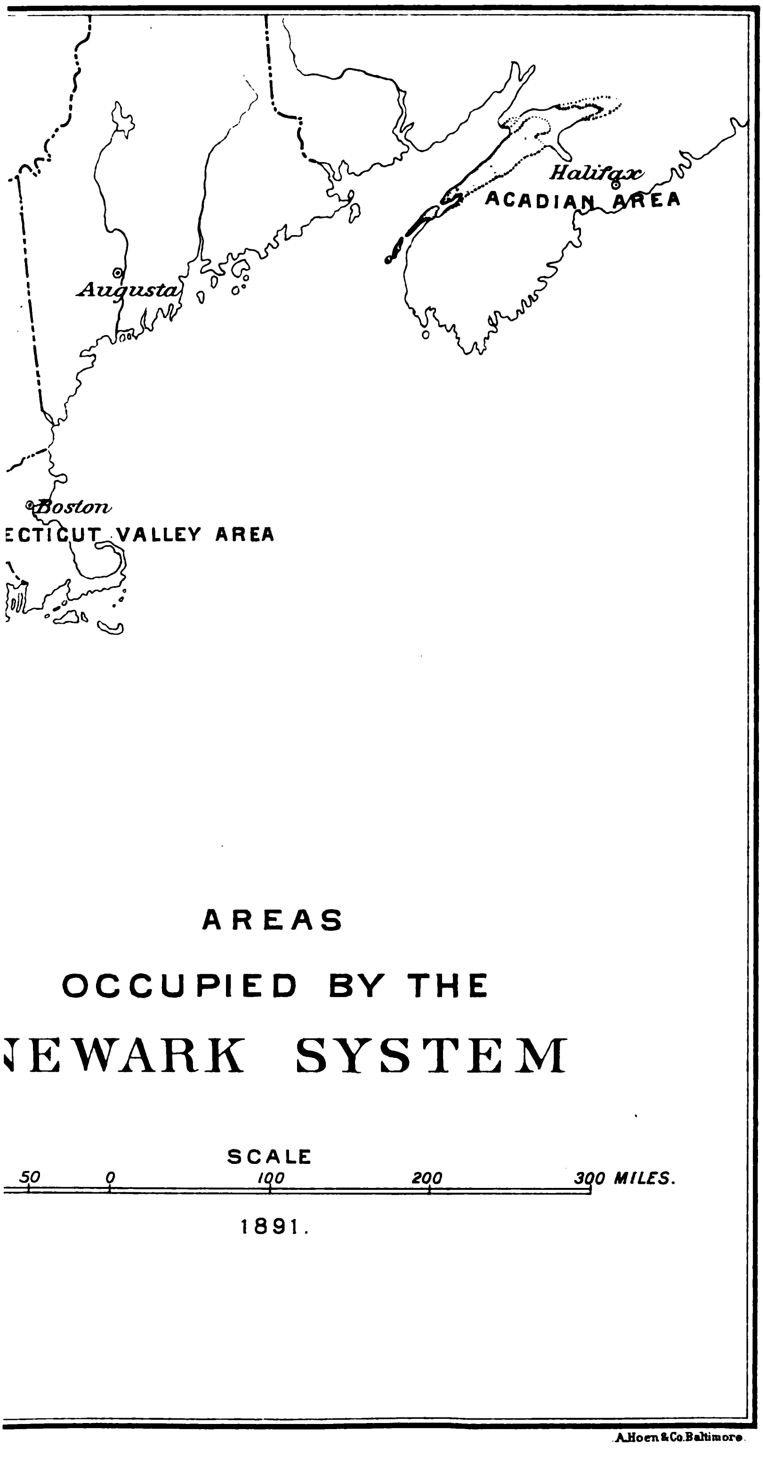

AREAS

OCCUPIED BY THE

EWARK SYSTEM

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UNITED STATES GEOLOGICAL SURVEY
J. W. POWELL, DIRECTOR

CORRELATION PAPERS

THE NEWARK SYSTEM

BY

ISRAEL COOK RUSSELL

WASHINGTON
GOVERNMENT PRINTING OFFICE
1892

CONTENTS.

Page.
Letter of transmittal 11
Outline of this paper 13
CHAPTER I. Nomenclature 15
    Table of names and correlations 16
CHAPTER II. Area occupied by the Newark system 19
    Acadian area 19
    Connecticut valley area 20
    Southbury area 20
    New York-Virginia area 20
    Barboursville area 21
    Scottsville area 21
    Danville area 22
    Dan river area 22
    Taylorsville area 22
    Richmond area 22
    Farmville area 23
    Deep river area 23
    Wadesboro area 23
    Summary—areas of distribution 24
CHAPTER III. Presence or absence of Newark rocks on Prince Edward island. 25
    Historical 25
    Discussion of the evidence 27
        Plants 28
        Animals 30
        Other indications of geological position 30
    Conclusions 31
CHAPTER IV. Lithology and stratigraphy 32
    Conglomerates and breccias 32
    Sandstones, shales, and slates 35
    Limestones 35
    Coal 36
        Quality of coal 36
        Natural coke 37
        Richmond area 38
        Farmville area 40
        Deep river area 41
        Dan river area 42
        Commercial development 42
    Thickness of the Newark rocks 43
CHAPTER V. Conditions of deposition 45
    Physical conditions 45
        Previous interpretations 45
        Conclusions 46

Page.
CHAPTER V—Continued.
Climatic conditions 47
Glacial hypothesis 47
Preservation of glacial records 49
Weight of the evidence of glaciation 50
Indications of a mild climate 52
Conclusions 53
Résumé 53
CHAPTER VI. Life records 54
Mammals 54
Batrachians and reptiles 54
Fishes 56
Insects 58
Crustaceans 59
Mollusks 60
Footprints 61
Plants 62
CHAPTER VII. Associated igneous rocks 66
Mineralogical composition 66
Chemical composition 68
Characteristics of trap dikes 69
Characteristics of trap sheets 69
Geographical distribution 70
Trap dikes outside the Newark areas 70
Trap rocks of the Acadian area 72
Trap rocks of the Connecticut valley area 73
Trap rocks of the New York-Virginia area 74
Trap rocks of the Newark areas south of the New York-Virginia area. 76
Summary respecting the distribution and age of the trap rocks 76
CHAPTER VIII. Deformation 78
Introduction 78
Structure of the Acadian area 80
Structure of the Connecticut valley area 80
Structure of the Southbury area 81
Structure of the New York-Virginia area 83
Structure of the Barboursville, Scottsville, Danville, and Dan river areas. 85
Structure of the Farmville area 88
Structure of the Richmond area 89
Previous observations 89
Personal observations 90
Section along the James river 90
West border of the area 91
East border of the area 92
Failures in mining due to geological structure 93
Absence of oil and gas 94
Structure of the Deep river area 94
Structure of the Wadesboro area 95
Summary 97
Origin of fault structure 98
CHAPTER IX. Former extent 101
The local-basin hypothesis stated 101
The broad-terrane hypothesis stated 103
Evidence favoring the local-basin hypothesis 104
Evidence favoring the broad-terrane hypothesis 104
Objections to the broad-terrane hypothesis 106
Conclusion 107

Page.
CHAPTER X. Correlation 108
  General principles 108
    Physical phenomena as a basis of correlation 108
      Superposition 108
      Contained fragments 108
      Relation to systems of folds, faults, and dikes 108
      Relation to unconformities 108
      Relation to glaciation 109
      Lithological similarity 109
      Summary concerning physical phenomena 110
      Chemical phenomena considered 110
    Life records as a basis of correlation 110
      Imperfections of the geological record 111
      Imperfections of our knowledge of the geological record 111
      Influence of distribution on the life records 112
      The life record continuous 113
      The European standard 113
  Principles on which widely separated terranes may be correlated 116
  Manner in which American terranes have been correlated 118
  Correlation of the Newark system 120
    Relation to terranes in the western part of the United States 121
    Relation to European terranes 122
      Testimony of the vertebrates 123
      Testimony of the crustaceans 125
      Testimony of the plants 125
  Summary 129
  Relation to terranes in Asia and Central America 131
  Literature of the Newark system 133

ILLUSTRATIONS.

		Page.
Plate I.	Map showing areas occupied by the Newark system	Frontispiece.
II.	Map of the Acadian area	18
III.	Map of Connecticut valley and Southbury areas	20
IV.	Map of the New York-Virginia and other Newark areas	21
V.	Map of Richmond areas	22
VI.	Newark areas in southeastern Virginia and North Carolina	23
VII.	Geological map of part of northern New Jersey, etc., Nelson H. Darton	24
VIII.	Macrotæniopteris magnifolia	62
IX.	Sections	90
X.	Bogan's cut, N. C., looking west	92
XI.	Fault in Bogan's cut, N. C	94
XII.	Fault in Bogan's cut, N. C	96
XIII.	Fault in Bogan's cut, N. C	98
Fig. 1.	Fault on east side of Connecticut valley area, after W. M. Davis	81
2.	Map and section of Southbury area, after W. M. Davis	82
3.	Ideal east and west section of Connecticut valley area previous to deformation	98
4.	Ideal east and west section of Connecticut valley area after deformation	99

LETTER OF TRANSMITTAL.

Department of the Interior,
U. S. Geological Survey,
Division of Geologic Correlation,
Washington, D. C., February 12, 1892.

Sir: I have the honor to transmit herewith a memoir by Mr. I. C. Russell on the Newark system, prepared for publication as a bulletin.

The Division of Geologic Correlation was created for the purpose of summarizing existing knowledge with reference to the geologic formations of North America and especially of the United States, of discussing the correlation of formations found in different parts of the country with one another and with formations in other countries, and of discussing the principles of geologic correlation in the light of American phenomena. The formations of each geologic period were assigned to some student already well acquainted with them and it was arranged that he should expand his knowledge by study of the literature and by field examination of classic localities and embody the results in an essay. The general plan of the work has been set forth on page 16 of the Ninth Annual Report of the Survey and on pages 108 to 113 of the Tenth Annual Report, as well as in the letter of transmittal of Bulletin No. 80.

The present essay is the sixth of the series, having been preceded by essays on the Carboniferous and Devonian, the Cambrian, the Cretaceous, the Eocene, and the Neocene, prepared severally by Messrs. Williams, Walcott, White, Clark, and Dall and Harris, and constituting Bulletins Nos. 80, 81, 82, 83, and 84.

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ognize the Jura-Trias as a single period. One of the principal questions proposed for Mr. Russell's consideration was thus decided in advance so far as the most important work of the Survey was concerned. The acceptance by the Survey of an opportunity for Alaskan exploration by Mr. Russell left to this division the option of diminishing the scope of the present essay or of postponing its completion, and the former alternative was preferred. It was consequently arranged that Mr. Russell restrict attention to the Newark system and the principles of correlation involved in the discussion of its relations.

The rocks of the Newark system occur in a number of separate areas. In this essay these are correlated one with another primarily on physical, secondarily on paleontologic evidence. Through paleontologic evidence the system is compared with formations west of the Mississippi river and with formations in Europe, and it is concluded that homotaxial relations are approximately determined. The feasibility of determining relations of close synchronism is questioned.

Very respectfully, your obedient servant,

G. K. GILBERT,
Geologist in Charge.

HON. J. W. POWELL,
Director U. S. Geological Survey.

OUTLINE OF THIS PAPER.

The aim of this paper is to review the progress of our knowledge concerning a well defined system of rocks on the Atlantic border, named the Newark system; to summarize the present state of information concerning it, and to discuss the bearing that its study has on principles of correlation.

Chapter I contains a historical summary of the numerous names by which the system has been designated from time to time, and also a statement of the author's reasons for adopting the term *Newark system* now used.

Chapter II contains a brief account of the geographical distribution of the various areas occupied by the system, and is accompanied by a series of maps on which the areas are shown, together with the relative age of the adjacent terranes.

Chapter III. The evidence as to the presence of Newark rocks on Prince Edward island is discussed and the conclusion reached that the system is not there represented.

Chapter IV. The lithological character of the sedimentary rocks of the system is described, and the evidence as to their thickness is presented. Coal is treated as a "rock," and some account given of its distribution and thickness.

Chapter V contains a discussion of the physical and climatic conditions under which the sedimentary rocks of the system were deposited. From an examination of the evidence bearing on the possible existence of glacial conditions in Newark times, the conclusion is reached that glaciers were not immediately concerned in the accumulation of any of the rocks of the system.

Chapter VI is a résumé of our knowledge of the life of the Newark period, as shown by the animal and plant remains that have been discovered.

Chapter VII deals with the igneous rocks which traverse the system in a great series of dikes and sheets. Following a description of the mineralogical and chemical composition of these rocks is a general account of the principal characteristics of dikes and sheets.

Chapter VIII is devoted to a description of the structure of the various Newark areas, and a discussion of its origin. The present inclination of the strata over broad areas is shown to be due principally to the tilting of faulted blocks. The effect of erosion on the upturned blocks is also considered. Original data are introduced concerning especially the structure of the more southern areas.

Chapter IX. The question of the original geographical extent of the system has been considered by several geologists, and diverse conclusions have been reached. In this chapter the opinions bearing on this question are summarized and classified under two heads: First, the "local-basin hypothesis," which includes those opinions based on the assumption that the stratified rocks of the system were deposited in several detached basins, the approximate boundaries of which are still traceable. Second, the "broad-terrane hypothesis," which embraces the conclusions of those who consider the detached areas of the system as remnants of possibly one broad terrane, which has been broken up by orographic movements and greatly eroded. The evidence is thought by the author to favor the second of these hypotheses.

Chapter X is devoted to a brief discussion of the general principles of correlation and of the relations of the Newark system to several other terranes.

Under general principles of correlation, the evidences from physical phenomena, such as superposition of strata, contained fragments, relation to folds and dikes, and to great unconformities, are considered. Under biological phenomena as a basis for correlation, the imperfections of the geological records and our incomplete knowledge of the records, such as they are, receive brief attention; as does also the bearing of evolution on the interpretation of the life history of the earth.

The difficulties in the way of correlating the rocks of America with those of other countries are indicated, and the conclusion is reached that the first aim in the study of the geology of a new country should be the definite determination of the sequence of rocks there represented, by physical phenomena, as a basis for the determination of the relative age of the faunas and floras they may contain. Subsequently, the fossils may be compared with those of distant terranes for the purpose of wider generalizations. It is pointed out that the life records in any restricted regions can not be accepted as a standard whereby to determine the age of fossil-bearing beds in other and especially in entirely disconnected terranes.

The chapter closes with a brief discussion of the relations of the Newark system to certain formations in the western part of the United States and in other countries.

THE NEWARK SYSTEM.

By Israel C. Russell.

CHAPTER I.

NOMENCLATURE.

The name "Newark system" has many synonyms. The body of rocks to which it is applied is naturally differentiated with peculiar clearness. It is separated from older rocks and from newer rocks by profound unconformities, and its boundaries are marked by strong lithological contrasts. For various reasons it is not easy to determine its precise position in the chronologic classification founded on the geologic systems of Europe. The synonymy has arisen not from doubt as to what should be included under one name, but from the fact that opinions as to correlation have been embodied in names, and these opinions have varied from time to time and from author to author. The name Newark is here preferred, because it is the oldest specific title not implying opinion as to geologic age. It was proposed by W. C. Redfield in 1856, in the following language:

> I prefer the latter designation [Newark Group] as a convenient name for these rocks [the red sandstone extending from New Jersey to Virginia], and to those of the Connecticut valley, with which they are thoroughly identified by footprints and other fossils, and I would include also the contemporaneous sandstones of Virginia and North Carolina.[1]

The term "group" used by Redfield and the term "system" here used do not imply any difference of conception, and the selection of one or the other is a matter of comparatively small importance. I have chosen system because it conforms approximately to the rule adopted by the International Congress of Geologists.

Something of the history of the study of the Newark system may be gathered from the following table, in which the various names by which it has been designated are arranged chronologically.

---

[1] Am. Jour. Sci., 2d ser., vol. XXII, 1856, p. 357; also in Am. Assoc. Adv. Sci., Proc., vol. X, Albany meeting, 1856, p. 181.

Names and correlations applied to the whole or to portions of the Newark system.

Date.	Name used.	Author.	Place of publication.
1817	Old red sandstone	Maclure, W	Am. Philo. Soc. Phila., Trans., vol. I, n. s., p. 20 and map.
1820	do	Silliman, B	Am. Jour. Sci., 1st ser. vol. II, p. 147.
1820	do	Nuttall, F	Acad. Nat. Sci. Phila., Jour., vol. II, p. 37.
1826	New, or variegated sandstone	Finch, J	Am. Jour. Sci., 1st ser., vol. X, p. 209.
1832	Old red sandstone and coal formation.	Hitchcock, E	Am. Jour. Sci., 1st ser., vol. VI, pl. op. p. 86.
1824	Freestone and coal formation of Orange and Chatham [N. C.].	Olmsted, D	Rep. Geol. N. C., p. 12.
1833	New red sandstone	Hitchcock, E	Rep. Geol. Mass., p. 206.
1835	Carboniferous	Taylor, R. C	Geol. Soc. Pa., Trans., vol. I, p. 294.
1836	Lias [?]	Redfield, J. H	Lyc. Nat. Hist. N. Y., Ann., vol. IV, p. 40.
1837	New red sandstone	Barratt, J	Am. Jour. Sci., 1st ser., vol. XXXI, p. 165.
1839	Silurian	Conrad, T. H	Am. Jour. Sci., 1st ser., vol. XXXV, p. 249.
1839	Middle secondary strata	Rogers, H. D	Third Ann. Rep. Geol. Pa., p. 12.
1842	Secondary formation	Percival, J. G	Rep. Geol. Conn.
1841	New red sandstone system	Hitchcock, E	Am. Jour. Sci., 1st ser., vol. XLI, p. 244.
1842	Keuper	Rogers, W. B	Am. Jour. Sci., 1st ser., vol. XLIII, p. 175.
1842	New red system; new red sandstone.	Emmons, E	Geol. of N. Y., part IV, p. 429.
1843	New red sandstone	Mather, W. W	Rep. Geol. of N. Y., part IV, p. 293.
1843	Old red sandstone and Coal Measures.	Cozzens, I	Geol. Hist. of Manhattan, p. 43.
1843	Permian	Murchison, R. I	Ann. Address Geol. Soc. London, p. 108.
1843	Oölite	Rogers, W. B	Assoc. Am. Geol. Nat., Trans., p. 298.
1844	New red sandstone	Silliman, B	Assoc. Am. Geol. Nat., Proc., pp. 14, 15.
1847	Triassic or Jurassic	Bunbury, C. J. F	Quar. Jour. Geol. Soc., Lond., vol. III, p. 288.
1847	Permian or Triassic	Lyell, C	Quar. Jour. Geol. Soc., Lond., vol. III, p. 275.
1847	Inferior Oölite?	do	Quar. Jour. Geol. Soc., Lond., vol. III, p. 278, 280.
1849	Keuper or Lias	Marcou, J	Géol. Soc. France, Bull., vol. VI, p. 575.
1849	Lower Carboniferous	Gesner, H	Industrial Resources of Nova Scotia, p. 244.
1850	Silurian	Jackson, C. T	Am. Jour. Sci., 1st ser., vol. III, p. 335.
1851	New red sandstone	Agassiz, L	Am. Assoc. Adv. Sci., Proc., vol. V, p. 46.
1851	Triassic	Lyell, C	Roy. Institution [of Gr. Br.], vol. I, p. 50.
1851	Post Permian	Redfield, W. C	Am. Assoc. Adv. Sci., Proc., vol. V, p. 45.
1853	New red sandstone or Keuper.	Marcou, J	Geol. Map of North America.
1853	Upper Permian	Lea, I	Phil. Acad. Nat. Sci., Jour., n. s., vol. II, p. 189.
1854	Jurassic	Rogers, W. B	Boston Soc. Nat. Hist., Proc., vol. V, p. 14.
1855	Oölitic	Taylor, R. C	Statistics of coal, 2d ed., p. 289.
1855	Near the Lias of Europe	Jackson, C. T	Am. Jour. Sci., 1st ser., vol. V, p. 186.
1856	Trias or new red sandstone.	Hitchcock, E	Outlines of the Geol. of the Globe, p. 96.
1856	Oölitic	do	Outlines of the Geol. of the Globe. Map.
1856	Newark Group	Redfield, W. C	Am. Jour. Sci., 1st ser., vol. XXII, p. 357.
1856	Triassic and Jurassic	Dana, J. D	Do.
1856	Trias and Permian	Emmons, E	Geol. Rep. N. C., p. 273.
1856	Jurassic	Rogers, H. D	Geol. Map of U. S. in Johnson's Phys. Atlas.
1857	Keuper	Heer, O	Geol. of N. Am. by J. Marcou, p. 16.
1857	Permian and Triassic	Emmons, E	American Geol., part VI, p. 1.
1857	Chatham series	do	Amer. Geol., part VI, p. 19.

Names and correlations applied to the whole or to portions of the Newark system—Cont'd.

Date.	Name used.	Author.	Place of publication.
1857	Keuper	Lyell, C	Cited by J. Marcou in Geol. of N. Am., p. 16.
1857	do	Heer, O	In Geol. of N. Am., by J. Marcou, p. 16.
1858	Lias	Agassiz, L	In Geol. of N. Am., by J. Marcou, p. 15.
1858	Mesozoic red sandstone	Rogers, H. D	Geol. of Pa., 4to., vol. II, p. 667.
1858	Refers various portions of the system to the Keuper Trias and Jurassic.	Marcou, J	Geol. of N. Am., pp. 10–13 and map.
1859	Between the new red sandstone and the Oölitic.	Agassiz, L	Am. Assoc. Adv. Sci., Proc., vol. IV, p. 276.
1860	Mesozoic or new red sandstone.	Tyson, P. T	First Rep on Agr. Chem., Maryland, map.
1861	Carboniferous	Stevens, R. P	New York Lyc. Nat. Hist. Ann., vol. VII, p. 414.
1864	Trias	Hall, J.. and W. E. Logan.	Geol. map of Canada.
1864	New red	Lesley, J. P	Am. Philo. Soc., Proc., vol. IX, pp. 478–480.
1865	Permian	Credner, H	Neues Jahrbuch, 1865, pp. 803.
1865	New red sandstone or Trias.	Matthew, G. F	Rep. on New Brunswick.
1866	Richmond coal field	Daddow, S. H., and Bannon, B.	Coal, Iron, and Oil, p. 395.
1866	Jurassic	Lyell, C	Elem. of Geol., 6 ed., p. 451.
1868	Triassic or red sandstone age.	Cook, G. H	Geol. of New Jersey, p. 173.
1869	Triassic period	Dana, J. D	Manual of Geol., p. 414.
1871	Trias	Lyell, C	Student's Elem. of Geol., p. 361.
1871	Triassic or Liassic	Shaler, N. S	Boston Soc. Nat. Hist., Proc., vol. XIV. p. 117.
1875	Triassic	Kerr, W. C	Rep. Geol. of North Carolina, p. 116.
1876	Permian	Owen, R	Quart. Jour. Geol. Soc. London, vol. XXXII, p. 359.
1876	Triasso-Jurassic	Lesquereux, L	Ann. Rep. U. S. Geol. and Geog. Surv., Hayden, for 1874, p. 283.
1878	Mesozoic formation	Heinrich, O. J	Am. Inst. Min. Eng., Trans., vol. VI, p. 227.
1878	Trias or new red sandstone.	Dawson, J. W	Acadian Geology, 3d ed., p. 86.
1878	Triassic	Russell, I. C	N. Y. Acad. Sci., Ann., vol. I, p. 220.
1878	Jura-Trias	Le Conte, J	Elem. of Geol., p. 439.
1879	Triassic-Jurassic	Dana, J. D	Am. Jour. Sci., 3d ed., vol. XVII, p. 330.
1879	Jurasso-Triassic	Rogers, W. B	Macfarlane's Railway Guide, p. 180.
1879	American new red sandstone.	Frazer, P	Am. Nat., vol. XIII, p. 284.
1879	Rhetic or Younger	Fontaine, W. M	Am. Jour. Sci., 3d ser., vol. XVII, p. 39.
1882	Triassic	Geikie, A	Text Book of Geol., p. 770.
1883	Older Mesozoic	Fontaine, W. M	Monograph No. VI., U. S. Geol. Surv.
1883	Rhetic	do	Do.
1883	Triassic	Davis, W. M	Mus. Comp. Zool., Bull., vol. VII, No. 9.
1884	Jurasso-Triassic	McGee, W J	5th Ann. Rep. U. S. Geol. Surv., vol. II.
1884	Lower Jurassic, passing downward into Triassic.	Hotchkiss, Jed	[Reprint of Rogers's Ann. Rep., etc., of Va.], Map.
1885	Triassic	Cope, E. D	Philo. Soc. Proc., vol. XXIII, p. 403.
1885	Triassic or Mesozoic	Lesley, J. P	Geol. Atlas of Pa., vol. X, p. vii.
1886	Tria-Jurassic	Chapin, J. H	Meriden Sci. Assoc., Proc., vol. II, p. 23.
1886	Triassic	Hitchcock, C. H	Am. Inst. Min. Eng., Trans., vol. XV, pl. op. 486.

Names and correlations applied to the whole or to portions of the Newark system—Cont'd.

Date.	Name used.	Author.	Place of publication.
1887	Tria-Jurassic or Jura-Triassic.	Chapin, J. H	Meriden Sci. Assoc., Proc. and Trans., vol. II, p. 23.
1887	Trias	Emerson, B. K	Gazetteer of Hampshire Co., Mass., p. 18.
1888	Upper Trias	Zeiller, R.	Géol. Soc. France, Bull, 3d ser., vol. XVI, p. 699.
1888	Triassic	Newberry, J. S.	Monograph vol. XIV, U. S. Geol. Surv.
1889	Newark system	Russell, I. C	Am. Geol., vol. III, pp. 178–182, vol. VII, 1891, pp. 238–291.
1890	Triassic	Marcou, J	Am. Geol., vol. V, p. 160.
1890	Connecticut, or Connecticut River sandstone.	Hitchcock, C. H.	Am. Geol., vol. V, pp. 200–202.
1890	Newark system	Darton, N. H.	U. S. Geol. Surv., Bull. No. 67.
1891	Jura-Trias	Dana, J. D	Am. Jour. Sci., 3d ser., vol. XLII, p. 79.

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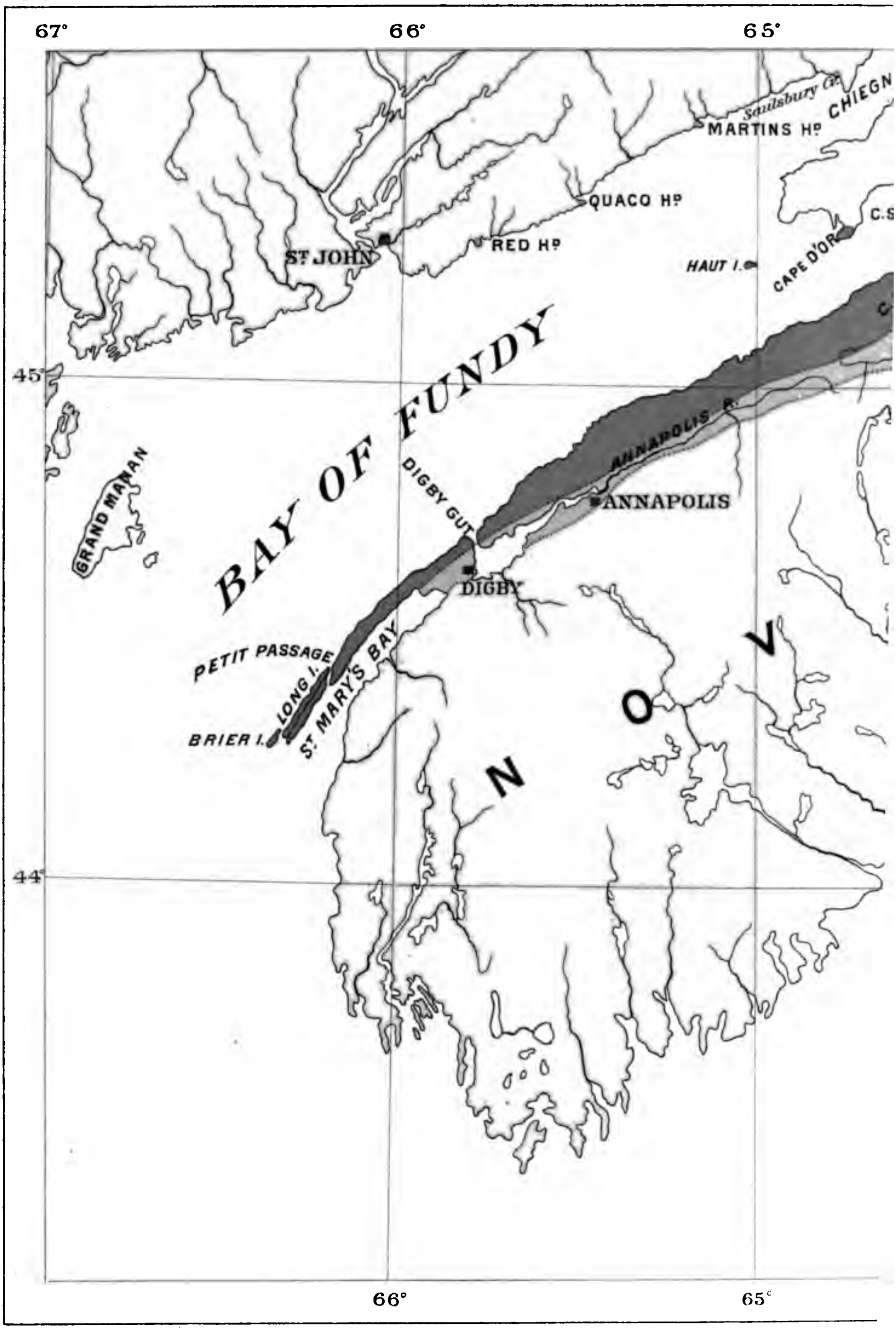
67°
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Saulsbury Cr.
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MARTINS Hᴰ
QUACO Hᴰ
C.S
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RED Hᴰ
HAUT I.
CAPE D'OR
C.
45°
BAY OF FUNDY
GRAND MANAN
DIGBY GUT
ANNAPOLIS R.
ANNAPOLIS
DIGBY
PETIT PASSAGE
LONG I.
ST MARY'S BAY
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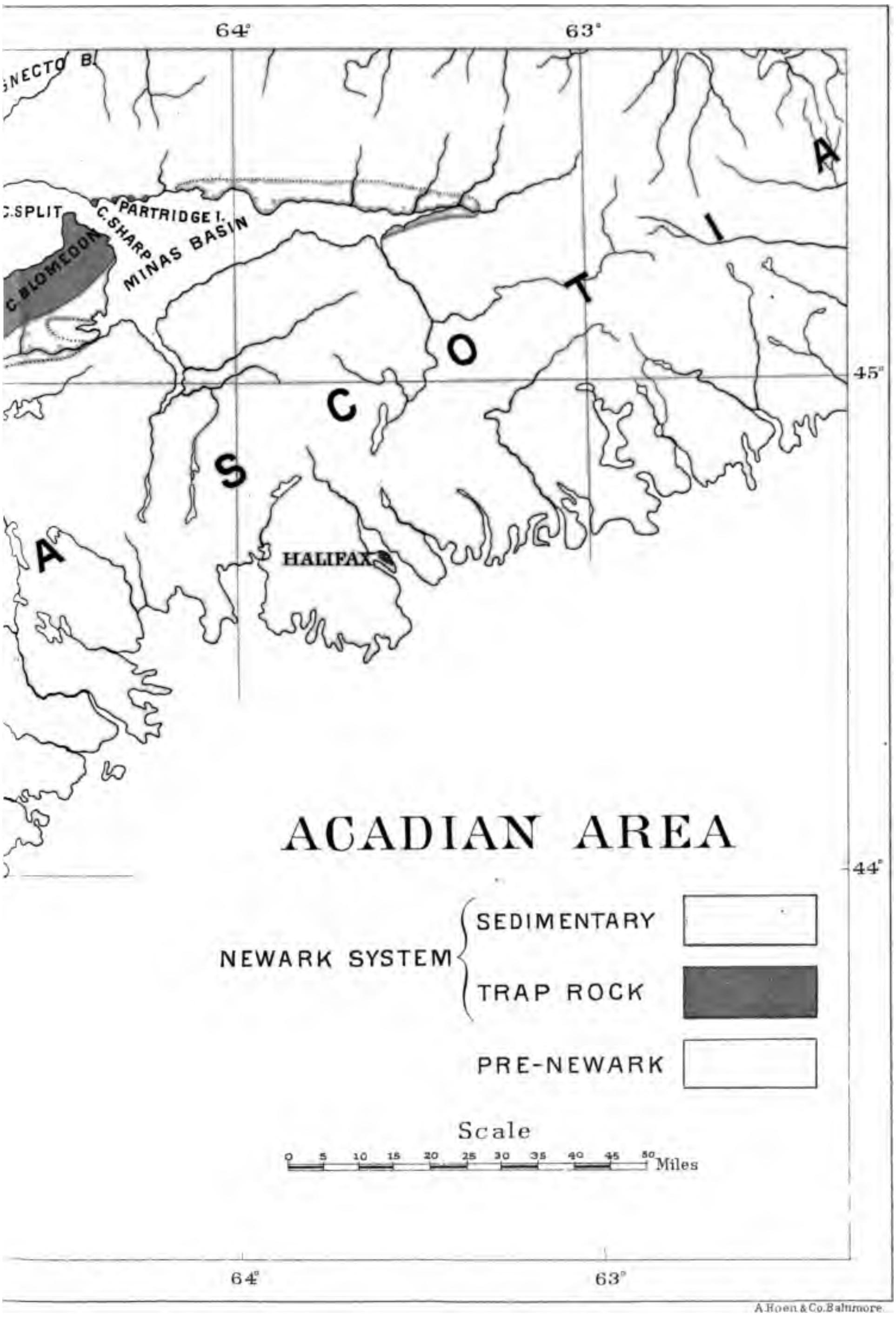

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CHAPTER II.

AREA OCCUPIED BY THE NEWARK SYSTEM.

In studying the Newark system it has been found convenient to give specific names to the several detached portions into which it is divided. The distribution of the principal areas, together with the names by which they are designated, are shown on the general map forming Pl. I (frontispiece). Each area is also shown on a larger scale on a separate map. These form Pls. II–VI, and in several instances indicate the positions of subordinate or secondary areas. Special names have previously been applied to some of these areas by Dana,[1] Fontaine,[2] Heinrich,[3] and others, and these will be retained so far as is practicable in the general scheme of classification now adopted.

The following descriptions of the various areas have been made brief, for the reason that the accompanying maps will enable the reader to determine their positions and boundaries more conveniently than could be done from detailed descriptions. The references given will serve to indicate where special information may be found.

ACADIAN AREA.

Acadian Area, Dana.

Under this name are included all the outcrops of Newark rocks in New Brunswick and Nova Scotia (Pl. II). In New Brunswick these rocks occur in small, detached areas at Red head, Quaco head, Martin head and Salisbury cove, on the west side of the bay of Fundy, each of which occupies probably less than 1 square mile.

In Nova Scotia it forms the east shore of the bay of Fundy from Blomidon to Brier island, a distance of about 120 miles. The width of this belt varies from 5 to 10 miles, excepting at the north, where it widens and forms a large part of the shores of the basin of Minas and Cobequid bay. A portion of Grand Manan island should perhaps also be included in this enumeration. The total extent of the Acadian area is approximately 1,050 square miles.

The distribution given above is shown in part by Dawson[4] on the map accompanying his "Acadian Geology," and in part on the geological atlas sheets published by the Geological Survey of Canada.[5]

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[1] Manual of Geology, 2d ed., New York, 1875, pp. 404–406.

[2] Notes on the Mesozoic of Virginia; in Am. Jour. Sci. 3d ser., vol. XVII, 1879, pp. 26–29, 31–37.

[3] The Mesozoic of Virginia; in Am. Inst. Min. Eng., Trans., vol. VI, 1879, pp. 228–238.

[4] Province of New Brunswick, Atlas sheets No. 1, N. E., and No. 1, S. E.

[5] The region occupied by the Acadian area is shown in part, on the Geological Map of Canada and Adjacent Regions, by James Hall and W. E. Logan, 1866; also on the map of the Dominion of Canada, geologically colored, from surveys made by the Canadian Geological Survey, 1842–1882.

The reason for not including Prince Edward island in this area, as has been done by many writers, is stated a few pages later.

CONNECTICUT VALLEY AREA.

Connecticut River Area, Dana.
Connecticut Valley Area, Dana.

This area occupies the Connecticut valley from a few miles south of the Massachusetts-Vermont boundary southward to Long Island sound, a distance of 110 miles. Near its eastern margin in Massachusetts there are two subordinate areas, one at Amherst and the other east of Turner Falls. Total extent about 2,000 square miles.

For the determination of the distribution of the Newark rocks in Massachusetts and Connecticut, we are indebted principally to the state surveys under the direction of Hitchcock and Percival. The map given on the accompanying plate has been compiled from Percival's geological map of Connecticut, and from a manuscript map of the geology of a portion of Massachusetts, kindly loaned by B. K. Emerson.[1]

SOUTHBURY AREA.

Southbury Area, Dana.

This outlier of the Connecticut valley area is situated 16 miles west of its western border, in the towns of Woodbury and Southbury, Connecticut. It is about 10 miles long, from north to south, and from 3 to 4 miles wide. Its outlines as shown on the accompanying plate (Pl. III) are from Percival's geological map of Connecticut, with some details added by W. M. Davis.

NEW YORK–VIRGINIA AREA.

Palisade Area, Dana.
New York Belt, Fontaine.
Potomac Deposit, Heinrich.

This area extends with unbroken continuity from the Hudson river, near Stony Point, New York, southward, through New Jersey, Pennsylvania, Maryland, and into Virginia as far as the Rapidan river, about 10 miles south of Culpeper (see Pl. IV). The distance in a straight line between its northern and southern extremities is about 300 miles. Its greatest width, where it is crossed by the Delaware, is 32 miles. Its area is about 5,000 square miles.

In Pennsylvania its width is greatly decreased, and the entire area bends westward and then southward. Its eastern margin is irregular, owing to deep erosion which has laid bare the Paleozoic rocks beneath. In Maryland it becomes again nearly north and south in trend, and west of Frederick, Maryland, is less than 3 miles broad. At the

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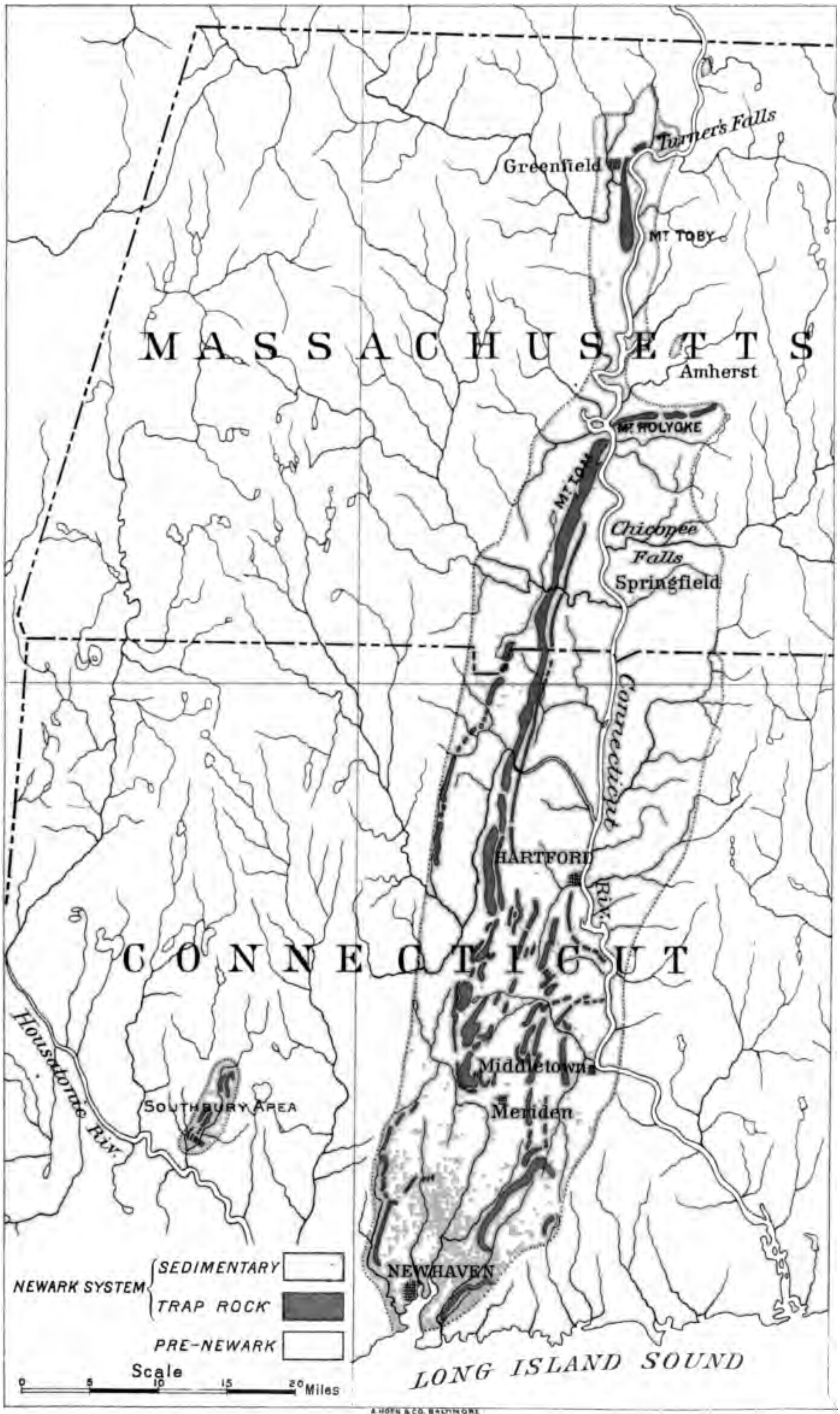
[1] This map has since been published in Bull. Geol. Soc. Am., vol. II, pl. XVII.



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MAP OF CONNECTICUT VALLEY AND SOUTHBURY AREAS.

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Potomac it increases suddenly in width to 17 miles, and terminates abruptly south of Culpeper.

The outline of this area, as shown on P. IV has been compiled from the geological maps published by the state surveys of New York, New Jersey, Pennsylvania, and Virginia. The boundaries in Maryland are from a manuscript map prepared by G. H. Williams, of the U. S. Geological Survey. The portion in Virginia has been corrected in part by N. H. Darton and Arthur Keith, of the U. S. Geological Survey, from recent observations.

The southern part of the New York-Virginia area, and all of the areas farther south in Virginia, described below, were mapped and studied by W. B. Rogers, during his survey of Virginia, and have since been described in detail by W. M. Fontaine and O. J. Heinrich, who availed themselves of previous observations in the same field. A map showing distribution of the various Newark areas in Virginia and the northern part of North Carolina, based largely on the work of Rogers, but containing some new data, was published by Heinrich in connection with his paper on the Mesozoic of Virginia.[1] The boundaries of the Newark rocks in Virginia are minutely described by Heinrich, and it is from his essay that most of the measurements of the Virginia areas given in this paper are obtained.

BARBOURSVILLE AREA.

Barboursville Deposit, Heinrich.

This area is really an outlier of the great New York-Virginia area, from the southern end of which it is separated by about 8 miles of crystalline rocks (Pl. VII). It is situated in Orange county, Virginia, to the west of Orange, and is named from the village of Barboursville, on its west border. It is elliptical in shape and measures about 9 miles from north to south and 2 miles from east to west. Its area is about 14 square miles.

SCOTTSVILLE AREA.

Buckingham Belt, Fontaine.
James River Deposit, Heinrich.

This area is situated immediately west of Scottsville, Virginia, and is probably composed of two or more detached belts, the boundaries of which are not definitely known (Pl. IV). The total area of the Newark outcrops in this vicinity, as computed by Heinrich, is from 40 to 45 square miles. They form a long, narrow belt, trending northeast and southwest, intermediate between the New York-Virginia area, already referred to, and the Danville area described below.

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[1] Am. Inst. Min. Eng., Trans., vol, VI, 1873, pp. 227-274.

DANVILLE AREA.

Part of Pittsylvania Belt, Fontaine.
Danville Deposit, Heinrich.

This area begins at the north near Falling river, in Campbell county, and extends southward across Staunton river to the north side of Dan river, just above Danville, Virginia (Pl. VI). Its extreme length from north to south is 54 miles, its greatest width 8 miles, and its area between 260 and 270 square miles.

DAN RIVER AREA.

Part of Pittsylvania Belt, Fontaine.
Dan River Deposit, Heinrich.
Dan River Coal Field, of various authors.

The northern end of this area is in Virginia, near Cascade creek some 10 miles west of Danville. From there it extends southward to Germantown, North Carolina, a distance of about 40 miles. Its greatest width is 8 miles, and its area approximately 200 square miles. Lakeville, North Carolina, is situated near its northern end (see Pl. VI).

TAYLORSVILLE AREA.

Taylorsville Deposit, Heinrich.

Taylorsville, Virginia, about 17 miles a little west of north of Richmond, is situated in the center of this area. Its width from east to west is about 8 miles, and its length from northwest to southeast approximately 10 miles. Its area is about 60 square miles (see Pl. V).

RICHMOND AREA.

Richmond Area, Dana.
Richmond Deposit, Heinrich.
Richmond Coal Field, of various authors.

The east border of this area is 11 miles west of Richmond, Virginia (see Pl. V). It is crossed from east to west by the James river, and thus divided into two unequal parts, the larger of which is to the south. Its extreme length from north to south, including a narrow spur which projects into the crystalline rocks at the north end, is 31½ miles. The main field, as determined by Heinrich, is 24 miles long from north to south, and 7½ to 10 miles broad. Its area is about 189 square miles.

Included under the name here used are several small detached basins along the eastern border of the main area. The most distant of these is the one in which the Deep Run mines are located, about 6 miles east of the northern end of the main area. The deposit at Deep run is designated as the Springfield deposit by Heinrich, and is stated to have an area of about 1·6 square miles.

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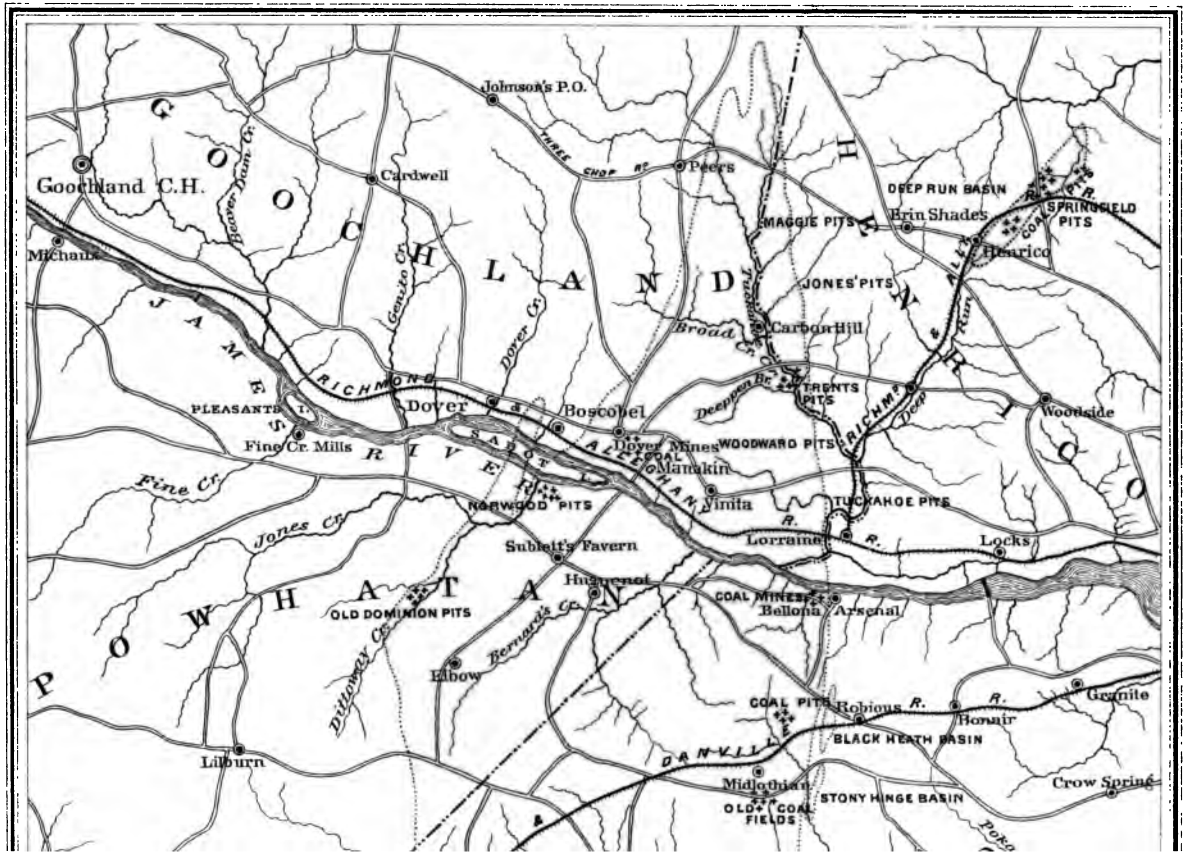
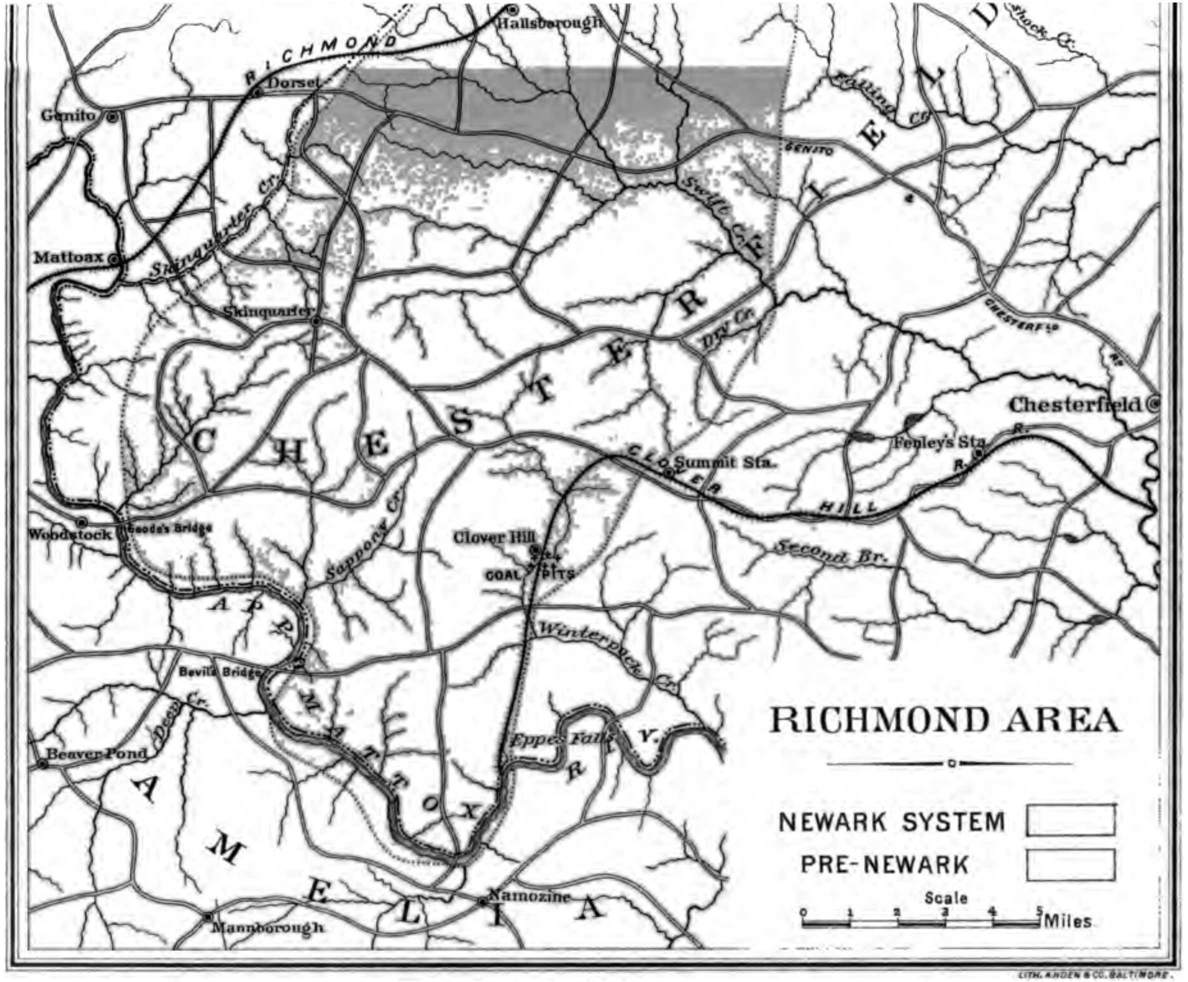

GOOCHLAND
HENRICO
POWHATAN
Goochland C.H.
Michaux
Johnson's P.O.
Cardwell
Peers
THREE CHOP RD.
Beaver Dam Cr.
Genito Cr.
Dover Cr.
Broad Cr.
Tuckahoe Cr.
Deep Run
Deepen Br.
DEEP RUN BASIN
SPRINGFIELD PITS
COAL PITS
Erin Shades
Henrico
MAGGIE PITS
JONES' PITS
Carbon Hill
TRENTS PITS
Woodside
WOODWARD PITS
Dover Mines
COAL
Manakin
Vinita
TUCKAHOE PITS
Lorraine
Locks
RICHMOND & ALLEGHANY R.R.
JAMES RIVER
SABOT I.
PLEASANTS I.
Dover
Boscobel
Fine Cr. Mills
Fine Cr.
Jones Cr.
NORWOOD PITS
Sublett's Tavern
Huguenot
OLD DOMINION PITS
Dilloway Cr.
Bernard's Cr.
Elbow
COAL MINES
Bellona
Arsenal
COAL PITS
Robious
Bonair
Granite
BLACK HEATH BASIN
RICHMOND & DANVILLE R.R.
Midlothian
OLD COAL FIELDS
STONY HINGE BASIN
Crow Spring
Lilburn
Poko



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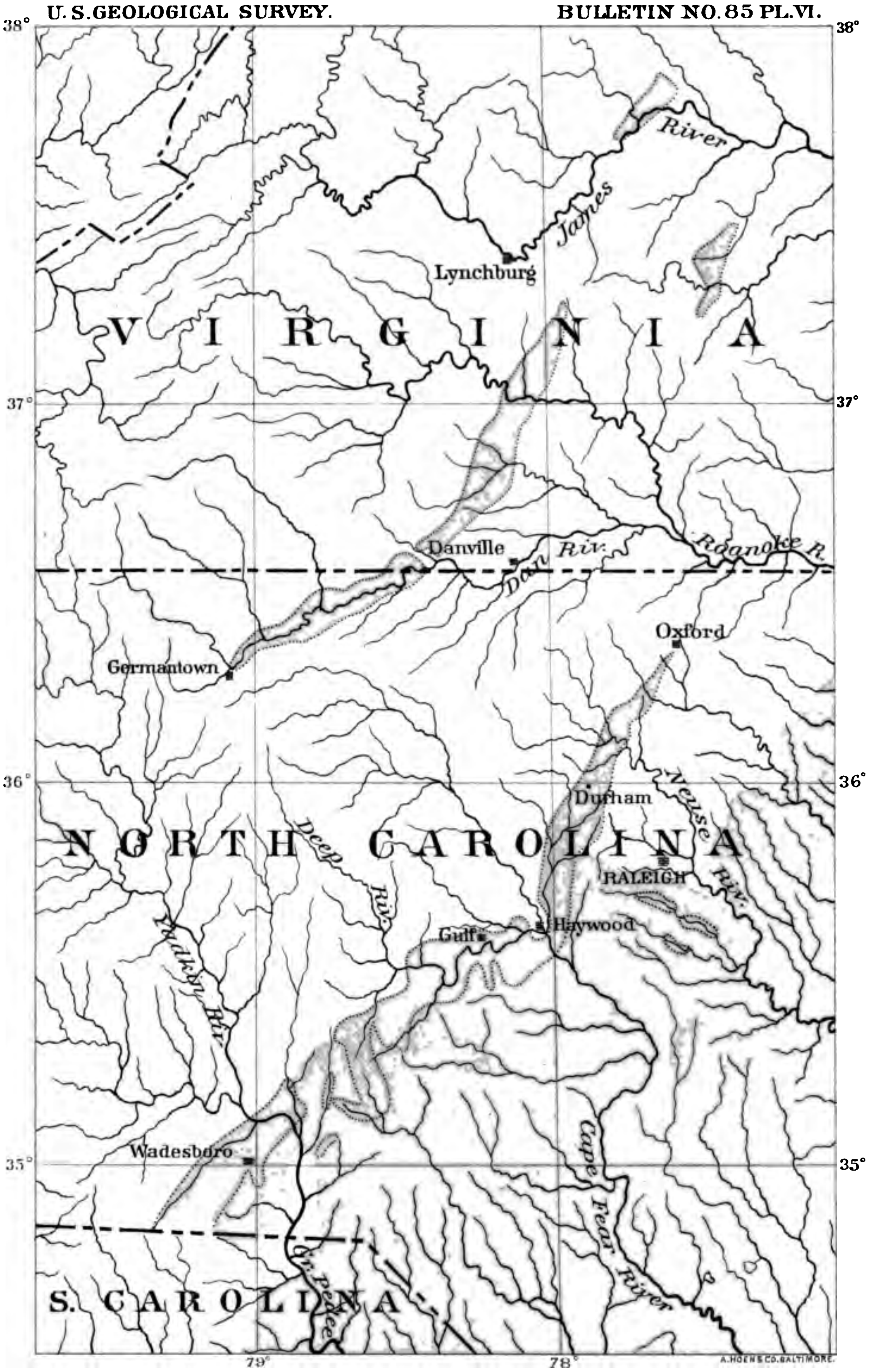

NEWARK AREAS IN SOUTHWESTERN VIRGINIA AND NORTH CAROLINA.

POST-NEWARK ☐ NEWARK SYSTEM ☐ PRE-NEWARK ☐

Scale 0 5 10 15 20 25 30 35 40 Miles.

FARMVILLE AREA.

Farmville Deposit, Heinrich.
Prince Edward Belt Fontaine.
Farmville Coal Belt of various authors.

Under this head are included two detached areas of Newark rocks, one on the south and the other principally on the north of the Appomattox river near Farmville, Virginia (see Pl. IV). The larger area lies to the northwest of Farmville and is crossed near its southern end by the Appomattox river; it is about 16 miles long from north to south, and 2 miles wide, and has an area of about 22 square miles. The smaller area is south of the river and is less than 2 miles long from north to south, and about a mile broad. The entire surface occupied by Newark rocks near Farmville measures about 24 square miles.

DEEP RIVER AREA.

Deep River Coal Fields, Emmons.
Part of "North Carolina Area," Dana.

This area is situated wholly in North Carolina, its northern terminus being near Oxford (See Pl. VI). It extends southward in an irregular belt for about 100 miles, and has an average breadth of approximately 8 miles, but its boundaries have never been accurately determined. Its area may be stated roughly at 800 square miles. Its outline, as shown on the accompanying map, is from Kerr's geological map of North Carolina, and as determined from a reconnaissance by the present writer is only approximately correct. Owing to the lack of topographic maps in this region, it has not been practicable up to the present time to determine its boundaries more accurately than was done by Kerr. I may state in passing, however, that its east border, near Raleigh, is distant about 8 miles from that city, instead of 16 miles as shown by Kerr.

The coal mines of Egypt, Gulf, etc., are situated in this area, and next to those of the Richmond area, are the most important in the Newark system.

On both the east and west borders of the main area there are detached basins occupied by Newark rocks, some of which are indicated on Kerr's geological map.

A description of the extent of this area was given by Emmons,[1] and portions of its outline were mapped by Wilkes.[2]

WADESBORO AREA.

Part of "North Carolina Area," Dana.

The northern end of this area is near Pekin, North Carolina. From that place it extends southward to the state line, a distance of about

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[1] Geological Report on the Midland Counties of North Carolina, 1856, pp. 227-254.

[2] Report on the Deep River Country, in North Carolina; in Report of the Secretary of the Navy to the Thirty-fifth Congress, second session, Senate Ex. Doc. No. 26, 1858.

30 miles. Its width near Wadesboro, where it is crossed by the Carolina railroad, is about 16 miles (see Pl. VI).

It has been stated by several writers that its southern end is in South Carolina, and it is so indicated on Kerr's map, but my own reconnaissance in that region indicates that it ends in North Carolina, close to the state boundary. Associated with it are several secondary areas, some of which were mapped by Kerr. The boundaries of the Wadesboro area, like those of the others in North Carolina, are only approximately known. Its area is in the vicinity of 275 square miles.

The Newark areas in North Carolina were studied by Emmons and Kerr during their respective surveys of the state and were mapped by Kerr.[1]

SUMMARY—AREAS AND DISTRIBUTION.

The Newark system is confined to the Atlantic border, and occurs in narrow belts, the longer, larger axes of which trend in general northeast and southwest, their general course being parallel to the folds of the Appalachians.

The distance in a straight line from the most northerly to the most southerly exposure is about 600 miles. The bearing of a line joining their two extremities is about northeast. The entire area occupied by the system is, in round numbers, 10,000 square miles.

Some of the areas were indicated in an indefinite manner on the geological maps of the United States by McClure and Marcou. They also appear on the recent geological maps of the United States, compiled by Bradley, Hitchcock, and McGee.

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[1] Report on the Geology of North Carolina, vol. I, 1875, map.

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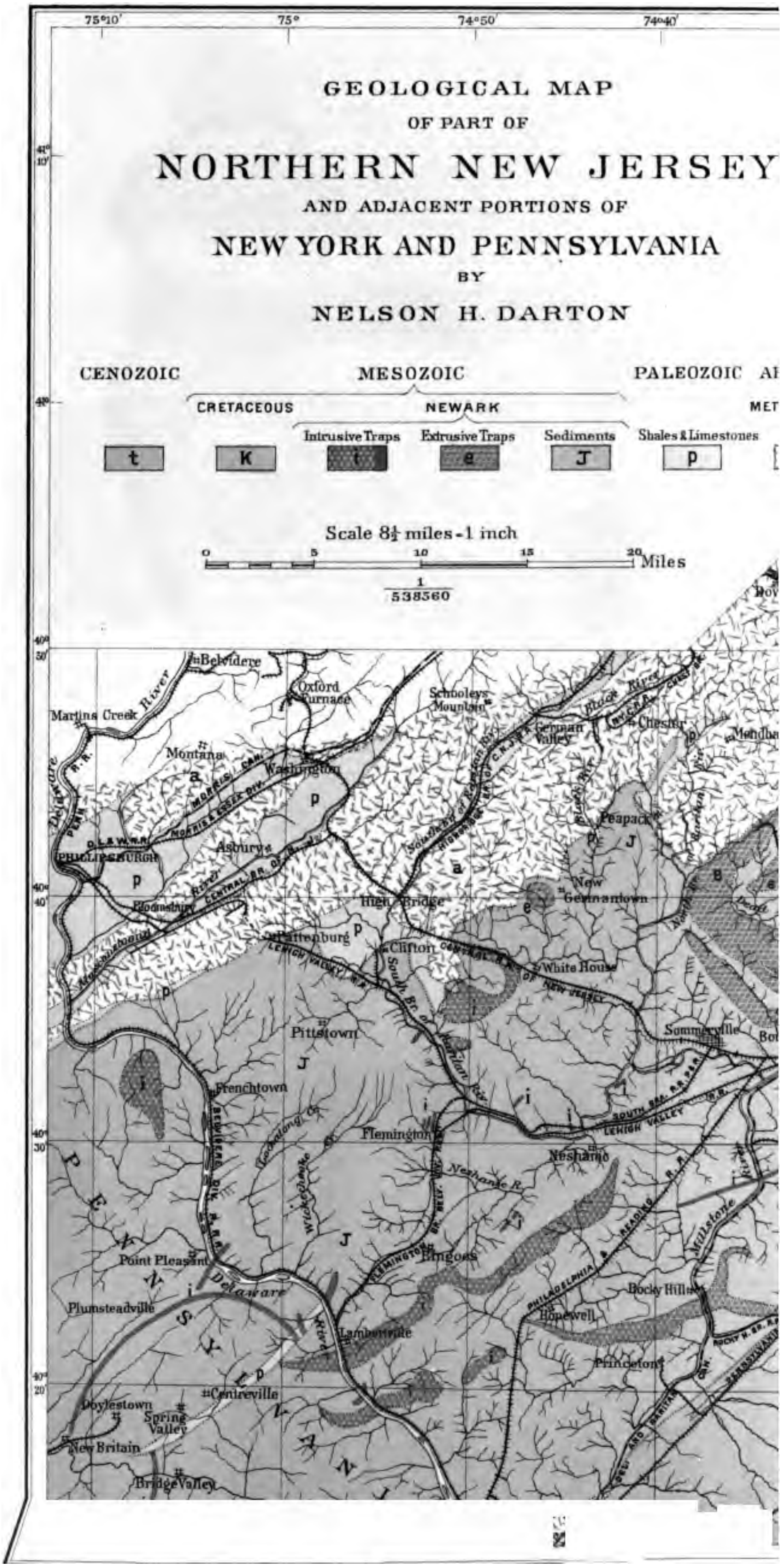

GEOLOGICAL MAP
OF PART OF
NORTHERN NEW JERSEY
AND ADJACENT PORTIONS OF
NEW YORK AND PENNSYLVANIA
BY
NELSON H. DARTON

CENOZOIC | MESOZOIC | PALEOZOIC A

CRETACEOUS | NEWARK | MET

Intrusive Traps | Extrusive Traps | Sediments | Shales & Limestones

t | K | i | e | J | p

Scale 8½ miles = 1 inch

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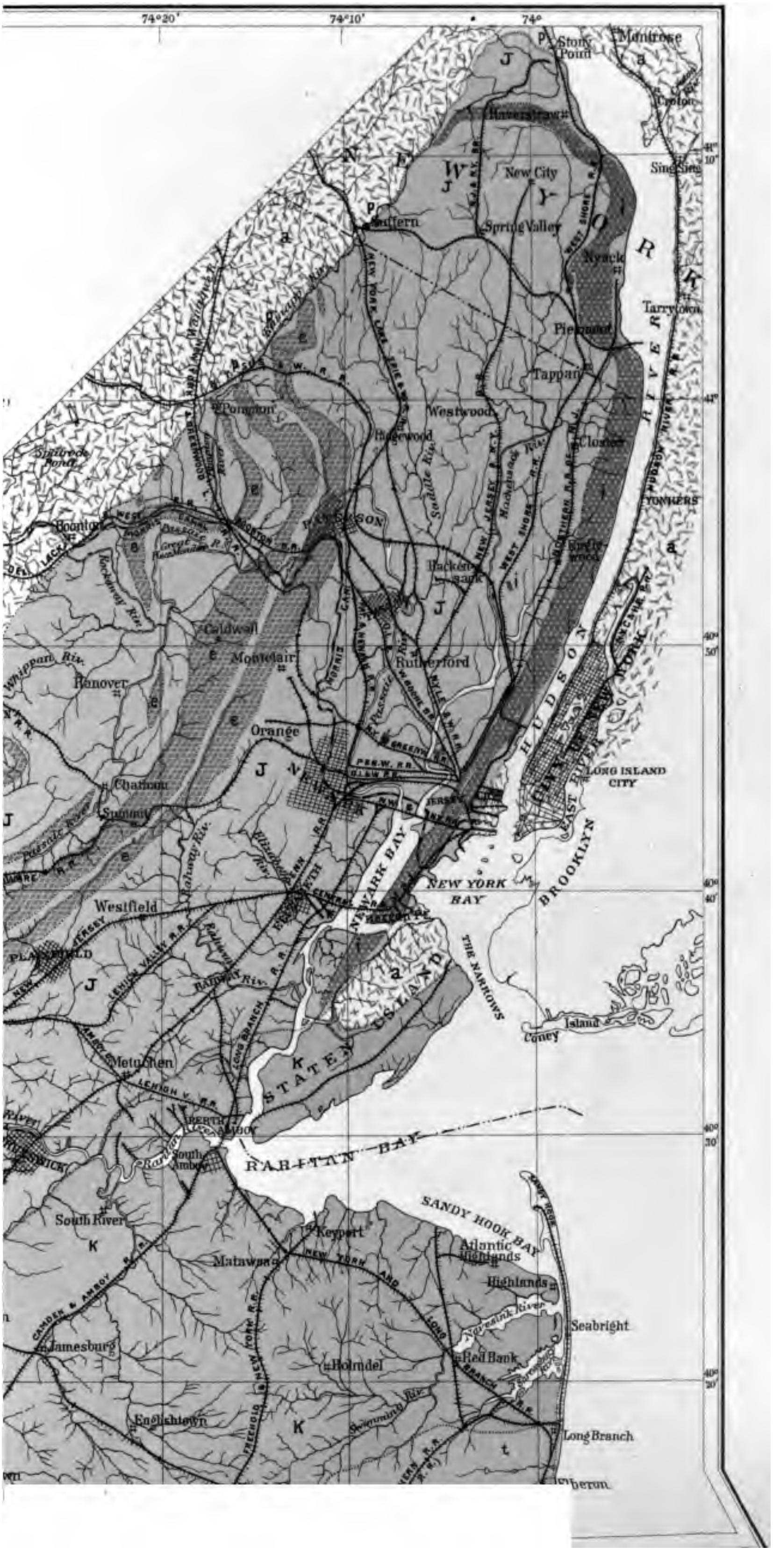
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NEW YORK
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Spring Valley
Nyack
Tarrytown
Piermont
Tappan
Westwood
Ridgewood
Closter
Pompton
Splitrock Pond
Boonton
Paterson
Yonkers
Englewood
Hackensack
Saddle Riv.
Hackensack Riv.
Rockaway Riv.
Whippany Riv.
Caldwell
Montclair
Rutherford
Hanover
Orange
Chatham
Summit
Passaic River
Rahway Riv.
Newark
Jersey City
Hudson River
East River
New York
Long Island City
Brooklyn
Westfield
Plainfield
Elizabeth
Newark Bay
New York Bay
The Narrows
Staten Island
Coney Island
Metuchen
Raritan River
Perth Amboy
South Amboy
Raritan Bay
Sandy Hook Bay
Sandy Hook
Keyport
Matawan
Atlantic Highlands
Highlands
Navesink River
Seabright
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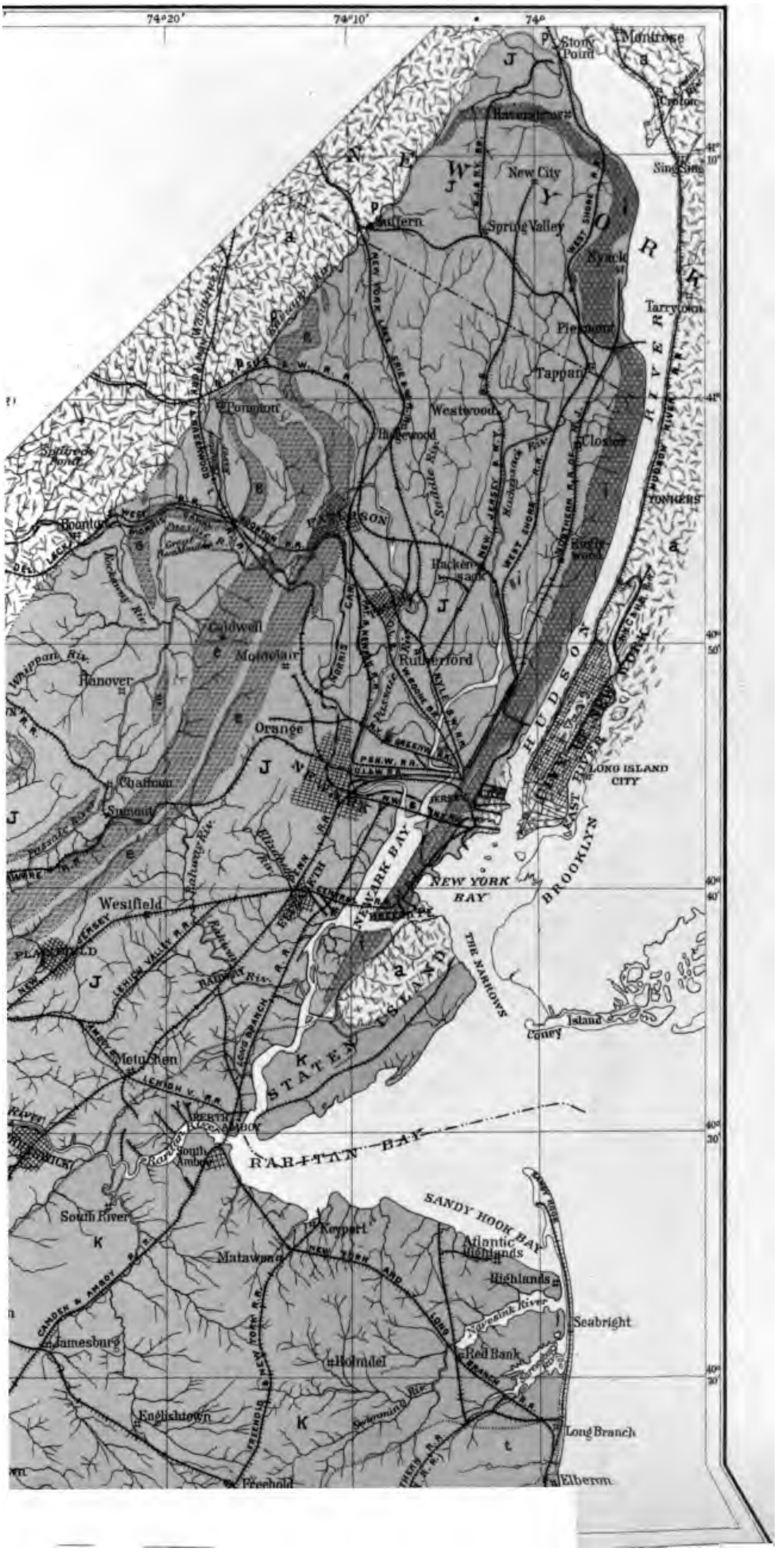
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Piermont
Tappan
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Ridgewood
Closter
Pompton
Boonton
Paterson
Yonkers
Englewood
Hackensack
Caldwell
Montclair
Rutherford
Hanover
Orange
Chatham
Summit
Newark
Long Island City
Brooklyn
New York
Hudson
East River
New York Bay
Newark Bay
The Narrows
Staten Island
Coney Island
Westfield
Plainfield
Metuchen
Perth Amboy
South Amboy
Raritan Bay
Raritan River
Sandy Hook Bay
Atlantic Highlands
Highlands
Keyport
Matawan
Seabright
Red Bank
Holmdel
Navesink River
South River
Jamesburg
Englishtown
Freehold
Long Branch
Elberon
Passaic River
Whippany Riv.
Rockaway Riv.
Rahway Riv.
Elizabeth Riv.
Saddle Riv.
Hackensack Riv.
Swimming Riv.
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West Shore R.R.
Hudson River R.R.
New York, Lake Erie & W. R.R.
Lehigh Valley R.R.
New York and Long Branch R.R.
Camden & Amboy R.R.
Morris Canal

to refer to the meagerness of these records, I quote his statement nearly entire, as it appears in the "Notes on the fossil flora of Prince Edward island," referred to above. The same evidence is presented also more or less fully in the writings of Dawson previously cited, and especially in the report of 1871. In describing the fossil plants Dawson says:

> The beds at Miminigash, Gallas point, St. Peter island, Governor island, Rice point, and other places on the south coast contain plants which elsewhere characterize the Upper Carboniferous and Lower Permian. At certain points in the interior of the island and in the bays of the north coast, which represent troughs between the Permo-Carboniferous anticlinals, there are found plants indicating a higher horizon. Here the characteristic Carboniferous species are absent, and their place is taken by others, either Permian or Triassic. For example, the abundant coniferous wood of the Carboniferous species, *Dadoxylon materiarium*, is replaced by an entirely different type more characteristic elsewhere of the Trias, *Dadoxylon edvardianum*. Some of the fossils found in this by Mr. Bain are undoubtedly of Permian aspect, as, for instance, the Walchias and *Calamites gigas*. Others, like the Dadoxylon above referred to and the curious *Cycadoidea abequidensis*, are undoubtedly more Triassic in aspect.[1]

The description of these plants is continued as follows:

> The few plants collected by Mr. Bain in the Upper Trias, or Trias proper, are especially interesting in consequence of the paucity of well preserved fossils in this formation. He finds in these beds a Calamites with very fine ribs of the type *C. arenaceous*, and which may be an internal cast of that Triassic species which, when perfect, is really an Equisetum rather than a Calamite, also certain Knorri-like branches different from Tylodendron, but probably branches of coniferous trees, and a species of Walchia apparently distinct from that of the lower beds. It has very stout and straight branches marked with interrupted furrows. Its branchlets are long, slender, and crowded, and at right angles to the branch. The leaves are closely appressed, triangular, and scale like. Detached branchlets have thus the aspect of the Mesozoic genus *Pachyphyllum*, but the habit of growth is that of Walchia. The species is near to *W. imbricata* of the European Permian, but sufficiently distinct to deserve a name, and I have therefore called it *W. imbricatula*. [Figure given.]
>
> It is to be observed that in the red sandstones of Prince Edward island all the more delicate plants and even twigs of coniferous trees have completely lost their organic matter and are represented by mere impressions, stains, or casts in clay or sand, so that it is very difficult to ascertain their minute characters.
>
> The general result, in so far as the subdivision of beds is concerned, would seem to be that the lower series is distinctly Permo-Carboniferous, that its extent is considerably greater than was supposed in 1871, that there is a well characterized overlying Trias, and that the intermediate series, whether Permian or Lower Triassic, is of somewhat difficult local definition, but that its fossils, so far as they go, lean to the Permian side. [Pp. 160, 161.]

DISCUSSION OF THE EVIDENCE.

The evidence advanced in favor of the presence of both the Permo-Carboniferous and Triassic systems on Prince Edward island is entirely paleontological. The absence of an unconformity between the lower and upper rocks and the similarity in their lithological characters are admitted by all. The evidence of the Newark age of the upper portion of the rock series is based on a small number of fossil plants and on a single reptilian fossil, which have been considered as indicating a parallelism with the Triassic Europe.

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[1] Op. cit., p. 158.

PLANTS.

The first of the fossil plants referred to by Dawson in the quotation given above is *Dadoxylon edvardianum*, determined from a microscopic study of fossil wood. It is related generically to other fossil woods found in the Carboniferous, and even as low down as the Devonian, and is represented by the Araucarias at the present day.

There is no reason why fossil wood should not be used as a means of determining geological horizons, if sufficient observations were recorded to determine the range of various genera and species. At present, however, only a few species of Dadoxylon are known, and these range from the Devonian upward to beyond the Mesozoic. The fact that the wood described by Dawson belongs to a hitherto unknown species of a genus of wide geological range does not indicate any definite horizon. As stated by Dawson, it has its nearest specific ally in the Trias of Europe, but also resembles a species from the Permian. If we knew the geological age of various species of this ancient pine more thoroughly, its evidence might have some weight; but at present it is a fact of interest, which it is proper to record, but can not be considered as having taxonomic importance.

The *Cycadoidea (Mantellia) abequidensis*, described by Dawson in the report for 1870, as evidence of the Triassic age of the sandstones of Prince Edward island, is based on a fragment of the trunk of a supposed Cycadeian plant, in which the structure has disappeared. It was found near Gallas point, in the immediate neighborhood of rocks that are admitted by all to be Permo-Carboniferous, and in rocks which Ells has since shown to belong to that system. Dawson refers this fossil, with doubt, to the Cycadoidea, for the reason that the limits of that genus are stated to be "less restricted than the genera *Mantellia* or *Carruthers*."

Besides the fossils just mentioned, the rocks under consideration have yielded certain obscure stems, for which Dawson creates the provisional genus "Knorria." These are stated to resemble closely certain Permian stems, described as *Schizodendron* of Eichwald, from the Permian of Europe. Whether related most nearly to the conifers or the cycads is uncertain.

In addition, there are certain flattened branches, referred to Sternbergia, and closing the list are obscure impressions referred to the fucoids.

The obscure condition in which these fossils are found is referred to by Dawson in the quotation given above. It is evident that their value as a means of determining geological age is small, on account of their imperfect preservation. There is not a single species in the list that has been found in other localities, and even the generic relations of all but the Dadoxylon are uncertain. In the rocks determined by Dawson as Permo-Carboniferous he finds Knorria-like stems and a species of *Sternbergia* which, from his description, can not be distinguished from those in the upper series. The genera *Walchia* and *Dadoxylon* also occur in the lower series. The specific identity of these plants is stated by Dawson to be different from those above; but to one reading his report the relation of the flora in the so-called Triassic rocks to the flora in the supposed lower series seems certainly more intimate than to any other flora cited by Dawson. Such relations as are pointed out seem more strongly Permian than Triassic.

To a geologist whose knowledge of paleobotany is but slight the evidence of geological age furnished by the plants in the upper portion of the sandstone of Prince Edward island seems to be very meager and unsatisfactory, but appears to tend toward Paleozoic rather than Mesozoic affinities.

While venturing to point out the small taxonomic value of the plants referred to above I do not wish to be understood as undervaluing the work of paleobotanists. By accumulating such evidence as has been recorded by Dawson and Bain we may ultimately have a reliable means of determining the identity of widely separated formations.[1]

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[1] Since writing the above I have had occasion to consult F. H. Knowlton of the U. S. Geological Survey in reference to certain specimens of fossil wood from the Newark system, and found that he had also examined the evidence as to the age of the rocks of Prince Edward island; his letter on this subject is here inserted:

I have examined the slides of the six pieces of fossil wood obtained by you from the Triassic of North Carolina, and, with the possible exception of one piece, have been able to identify them to my entire satisfaction with *Araucarioxylon arizonicum* Knowlton. This species was described (Proc. U. S. Nat. Mus., vol. XI, 1888, pp. 1-4, pl. I) from specimens collected in New Mexico and Arizona from the Shinarump group of Powell; I have also recently detected the same species, or at most only a slightly divergent variety of it, from the vicinity of the copper mines near Abiquiu, New Mexico.

This species is entirely unlike *Dadoxylon Edvardianum* described by Dawson from the so-called Triassic of Prince Edward island.

In regard to Prince Edward island, a portion of which has been referred to the Triassic by Dawson, largely upon paleobotanical evidence, I may say that I have been over the evidence with some care, and in the absence of the actual specimens for study and comparison, I think I am safe in saying that the data upon which he bases his conclusions are by no means sufficient or satisfactory. The only two forms to which he gives specific names are new to science and, *as species*, can of course have no weight in determinining stratigraphic position but *as genera* they may have.

The first species, *Dadoxylon edvardianum*, is regarded by Dawson as being closely allied to two species from the Permian and one obscure species from the Keuper. Now, as at present understood the genus Dadoxylon does not come up into the Mesozoic, but is a Devonian or Carboniferous genus. Moreover, judging from the somewhat crude figures, it belongs decidedly to the more ancient forms showing the Araucaria-like structure characteristic of the Paleozoic, rather than the more highly differentiated forms which are now referred to Araucarioxylon.

Sternbergia is a Paleozoic genus and represents the pith of Cordaites, a genus which never goes above the Permian and had its maximum development in the Devonian and early Carboniferous.

Knorria is of no value in the present instance in determining age, since Dawson says they "very closely resemble the *Permian* stems to which Eichwald has given the name "Schizodendron," and further show internal structure similar to that of stems from undoubted Carboniferous strata (Gallas point) already referred to Dadoxylon.

Fucoids.—These are also of no value in the present case as they are very obscure and are doubtfully regarded as being fucoidal.

Cycadoidea.—This is the other form to which Dawson has given a specific name, and if it is really a cycad undoubtedly argues a Mesozoic age even later than the Triassic. But without the specimen in hand, and only judging from the figure of it, it seems not improbable that it may be a cone of some conifer, particularly when we remember the other things with which it is associated, and further than this the specimen is doubtfully from what he calls Triassiac. It is the only thing which is characteristically Mesozoic.

As for the value of the Dinosaurian remains (*Bathygnathus borealis*) I am of course unable to judge.

Very truly, yours,

F. H. KNOWLTON.

ANIMALS.

Vertebrate fossils.—In discussing the age of the sandstones of Prince Edward island the fossil reptile known as *Bathygnathus borealis* is frequently referred to. This is the only fossil besides plant remains now known from these rocks. The fossil bone with teeth, on which the genus and species mentioned were founded, was obtained by Dawson near New London, on the north side of the island, and described and figured by Leidy[1] in 1854. The remains were referred to the New Red Sandstone by Dawson and Leidy on geological determinations simply, and not on account of the zoological relations of the fossil. Even the family to which *Bathygnathus* belonged was not established until long afterwards, if it is now definitely fixed. In a later discussion of the age of the rocks in which this fossil was found, it is advanced as evidence that they are Triassic. This reasoning is not such a complete circle as it appears, however, as our knowledge of fossil reptiles has been greatly increased since *Bathygnathus* was described, and it has been determined by Cope that its nearest relation is to the Dinosaurs, which had their greatest development in Mesozoic time.

The fossil referred to was described by Leidy "as the right dental bone" of the lower jaw, with seven teeth attached. Its position was reversed, however, by Owen,[2] who claims that the bones are portions of the "skull, including the left maxillary, premaxillary, and nasal bone." It is considered by Owen as a Theirodont reptile, probably of Permian age.

Able paleontologists thus differ as to the zoological affinities of *Bathygnathus*, and as it is the sole representative of a genus, its value to the geologist as a means of identifying the horizons of the strata in which it occurs is not conspicuous. If a *Dinosaur*, as considered by several paleontologists, it would seem to indicate that the rocks in which it occurs are Mesozoic. If a *Theirodont*, as claimed by Owen, it would indicate a Permian age. To the geologist who must look to the paleontologist for the determination of the fossils he finds, the evidence of age furnished by *Bathygnathus* seems nearly equally divided between the Paleozoic and Mesozoic, but bending perhaps more strongly toward the latter.

OTHER INDICATIONS OF GEOLOGICAL POSITION.

Trap rock, undistinguishable from the similar rocks so abundant throughout the Newark system, occurs at a single locality on Prince Edward island. This has been considered by some as evidence of the Triassic age of the sedimentary beds with which it is associated. Elsewhere in this paper it is shown that the trap rocks of the Newark system belong to a vast series stretching for nearly 1,000 miles along the Atlantic coast. This series appears in the sedimentary beds of the

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[1] On *Bathygnathus borealis*, an Extinct Saurian of the new red sandstone of Prince Edward island. In Philadelphia Acad. Nat. Sci. Jour., 2d ser., vol. II, 1850–1854, pp. 327–330, pl. XXXIII.

[2] Evidence of the Theirodonts in Permian deposits elsewhere than in South Africa. In Geol. Soc. of London, Quart. Jour., vol. XXXII, 1876, pp. 352–366.

Newark system as dikes and sheets, and occurs also in dikes in the rocks surrounding the various Newark areas, and cutting formations of all ages from the Archean upward to the base of the Potomac, but does not occur in rocks younger than the Newark. The only evidence of age, therefore, that can be claimed for the trap on Prince Edward island is that the rocks which it penetrates are presumptively not younger than the Newark system; they may belong to the Carboniferous or to any older series.

Throughout the various areas of the Newark system from North Carolina to Nova Scotia there is a great unconformity between the rocks of that system and those on which it rests. On Prince Edward island an unconformity between the rocks referred to the Permo-Carboniferous and those supposed to be of Newark age is wanting. While the absence of such an unconformity does not prove that there is but one system of rocks on Prince Edward island, it is strongly suggestive that such is the case.

In discussing the age of the rocks in question, nearly all comparisons have been made with the Triassic and other formations of Europe. What is of special interest, however, is their relation to the Newark system. This, it is to be presumed, can be better attained by a direct comparison than by comparisons through a more distant formation. Evidence of the relation of rocks of Prince Edward island to those of the Newark system may be looked for (1) in the fossils they contain; (2) in the lithological resemblances of the beds to those of the Newark system; and (3) their structural relations to other systems, the relations of which to the Newark are known:—

1. No fossils are known to be common to the rocks of Prince Edward island and to the Newark system.

2. Lithologically the rocks in question on Prince Edward island, as stated by Ells and others, differ widely from the rocks of the Newark system in the Acadian area, with which they are geographically nearest related; and besides, they bear a marked resemblance to the Permo-Carboniferous rocks on which they rest, and to those of New Brunswick.

3. Throughout all of the various Newark areas, as will be described later in this paper, there is a great unconformity between the rocks of the Newark system and the formations, some of which are Carboniferous, on which they rest.

CONCLUSIONS.

The absence of Newark fossils in the rocks of Prince Edward island; the close lithological similarity of the beds in the upper and lower portions of the sections there exposed, the lower rocks being Permo-Carboniferous; and the lithological difference of the rocks from the sandstone and shales of the Newark system, seem to me sufficient ground for not considering any portion of the stratified rocks of Prince Edward island as belonging to the Newark system.

CHAPTER IV.

LITHOLOGY AND STRATIGRAPHY.

The main portion of the Newark system is composed of conglomerate, breccia, arkose, sandstone, shale, and slate.[1] Of these sandstone and shale are by far the most abundant. There are besides a few thin limestone layers and deposits of coal. The igneous rocks are described in a separate section.

CONGLOMERATES AND BRECCIAS.

Coarse deposits, composed of both rounded and angular stones, occur especially at the base of the system, and along the borders of some of the areas.

Conglomerates have been reported by Emmons[2] in some of the southern areas in the medial portion of the system, or, at least, far above its base, but in some instances, as shown by my own observations, these exposures are portions of the basal conglomerate, brought to light by faulting. The prevailing structure of the system was not recognized at the time Emmons made his survey of North Carolina, and the hypothesis that the presence of conglomerates at the surface in the central portions of the Newark areas might be due to faulting was not considered. No unconformities by erosion have been recorded at the horizons where the conglomerates referred to are supposed to occur, and additional study is necessary before such marked physical changes in the history of the system as would be implied by the presence of a widespread stratum of coarse material far above its base, can be accepted as proved.

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[1] Descriptions of the character and distribution of the clastic rocks of the Newark system may be found in the following works:

Acadian area: J. D. Dawson, Acadian Geology, 2d and 3d ed., pp. 86–124.

Connecticut valley area: J. G. Percival, Rep. Geol. Connecticut, 1842, pp. 426–452. Edward Hitchcock, Final Rep. Geol. Massachusetts, 1841, vol. II, pp. 441–446.

New York-Virginia area: W. W. Mather, Geol. of New York, 1843, pp. 285–289. H. D. Rogers, Description of the geology of New Jersey, Final Report, 1840, pp. 117–141. G. H. Cook, Geology of New Jersey, 1868, pp. 206–226. G. H. Cook, Geol. of New Jersey, Ann. Rep. for 1882, pp. 17–43. N. H. Darton, U. S. Geol. Survey, Bull. No. 67, 1890. H. D. Rogers, Geol. of Pennsylvania, 1858, vol. II, pp. 667–680.

New York-Virginia and other areas to the south: W. B. Rogers, A reprint of annual reports and other papers on the geology of the Virginias, 1884, pp. 323–328, 475–480. O. J. Heinrich, Mesozoic formation of Virginia; in Am. Inst. Min. Eng., Trans., vol. VI, 1878, pp. 227–274, W. M. Fontaine, Notes on the Mesozoic of Virginia; in Am. Jour. Sci., 3d ser., vol. XVII, 1879, pp. 25–39, 151–157. Ebenezer Emmons, Geological report of the midland counties of North Carolina, 1856, pp. 227–268.

The building stones of the Newark system have been described by S. W. Hawes, Report on the building stones of the U. S.; in Tenth Census of the U. S., vol. X, 1884, pp. 25–27, pl. 13. N. S. Shaler, Report on the building stones of the U. S.; in Tenth Census of the U. S., vol. X, 1884, pp. 126, 127, 141–144, 155–157, 177, 178, 179, 180, 181, 182, pls. 45, 46. S. P. Merrill, Collection of building and ornamental stones in U. S. National Museum; in Smithsonian Inst. Ann. Rep. for 1885–'86, pp. 277–648.

[2] Emmons, Ebenezer: Geol. Rep. of the midland counties of North Carolina, 1856, pp. 227–239; also, American Geology, part VI, Albany, N. Y., 1857, pp. 9–11.

The important and characteristic conglomerate of the system occurs at its base, and is quite generally exposed along the borders of the various areas toward which the rocks dip.

In the Acadian area the lower rocks are coarse, and form characteristic conglomerates, as is shown by exposures on the borders of the basin of Minas, and in isolated patches on the west side of the bay of Fundy.

In the Connecticut valley a coarse conglomerate, sometimes containing rounded bowlders 2 or 3 feet in diameter, occurs along the eastern margin of the area and about its northern end, but is seldom seen on its west border.

Coarse deposits also form the basal portions of the Southbury area.

In the New York-Virginia area a coarse brecciated conglomerate occurs at intervals all along the western margin. The same is true of the detached areas farther south, which fall in line with the New York-Virginia area. These are the Barboursville, Scottsville, Danville, and Dan river areas. On the east side of the New York-Virginia area coarse deposits are mostly wanting, but have been observed at a few localities in New Jersey and Pennsylvania. Beneath the Palisades along the west bank of the Hudson the basal conglomerate is represented by a coarse arkose, apparently derived from the waste of an area of feldspathic gneiss. Coarse brecciated conglomerates occur also in the more easterly areas in Virginia and North Carolina, but, contrary to what might perhaps be expected, are frequently exposed on their west borders and but seldom seen along their eastern margin. It is also frequently well exposed in small linear, outlying patches of Newark rocks, near the borders of the Richmond, Farmville, Deep river, and Wadesboro areas. These detached or secondary areas adjacent to the larger ones owe their preservation to the downward faulting of the Newark beds, which has carried portions of the basal member of the series below the plane of present denudation. The conglomerates exposed in these situations are clearly portions of the basal conglomerate.

The general absence of coarse conglomerates along the eastern border of the southeastern areas just mentioned is due, in part, to the presence of marginal faults, which bring fine offshore deposits of the Newark system in direct contact with the encircling crystalline rocks. In other places the junction of the Newark system with the crystallines is obscured by quite recent sedimentary beds and by the products of subaerial decay, so that it is difficult to determine the nature of the rocks near the line of contact.

A study of the voluminous reports and essays of various geologists, a portion of which are indicated in the foot note on page 32, aided by a personal reconnaissance, seems to warrant the conclusion that the basal portion of the system is generally a coarse brecciated conglomerate, having a thickness ranging from a few feet to perhaps 150 feet. Over considerable areas, especially along the west border of the Connecticut valley area and the east border of the New York-Virginia area, the lower beds are fine and must have been deposited at a distance from shore. The shore line against which the Newark rocks were deposited at various stages may frequently be distinguished by a marked thickening and an increase in the size of the fragments composing the basal conglomerate.

The marginal conglomerate is not a separate and independent formation capping the Newark system, as has been at times supposed, but is an extension and a local thickening of the basal conglomerate. Coarse deposits extended out from the ancient shore line in certain localities, as has been stated, and on their outer margins became interstratified with finer offshore sediments. The coarse shore deposits and the finer offshore deposits overlap and form a heterogeneous terrane.

In speaking of the former shore of the Newark estuary, it is not intended to convey the idea that the shore line at the last stage of deposition is still preserved. The whole region occupied by the Newark system has been upheaved since the last of its strata were laid down, and reduced to a base level by erosion. This process has possibly been repeated more than once. The result is that the marginal conglomerates now exposed belong in large part to the earlier stages in the deposition of the system. Neither do all of the shore deposits now exposed belong to a single horizon. As will be mentioned when the structure of the system is described, the plane of base-level erosion which determined the present surface of the Atlantic slope cuts deeper into the Newark rocks in North Carolina and Virginia than it does in New Jersey and the Connecticut valley. The marginal conglomerates are composed of both rounded and angular débris derived from adjacent portions of the encircling crystalline and Paleozoic terranes. In places it is highly calcareous, and is used for ornamental building stone and for the manufacture of lime. At other places it is largely composed of quartz pebbles and is sufficiently compact to be used for millstones. Again, it is made up of schists and slates, and can scarcely be distinguished, especially when somewhat decomposed, from the rocks of the adjacent gneissic areas from which its material was derived. The conglomerate, when calcareous and when largely composed of quartz pebbles, is usually light colored, commonly gray. It frequently carries the remains of tree trunks and branches, now changed to lignite, and obscure impressions of leaves. At other localities it is highly ferruginous, barren of fossils, and passes by insensible gradations into the ordinary brown sandstone, which is the most widely known rock of the system. In all cases, so far as can now be judged, the coarse deposits are of local origin and were derived from neighboring shores.

Associated with the coarse shore deposits, especially in the Connecticut valley and in New Jersey, there are fine, dark carbonaceous slates which contain fossil fishes and the impressions of plants.

SANDSTONES, SHALES, AND SLATES.

The greater part of the clastic rocks of the Newark system are reddish brown sandstones and ferruginous shales. These grade into each other so as to form a great variety of lithologic variations, ranging from a compact and almost vitreous sandstone to friable shales and clays so soft that they crumble between one's fingers.

Interstratified with these deeply colored rocks are occasional layers of gray sandstone and mottled shales. Although light colored strata are present in considerable thickness in certain localities, they are not sufficiently abundant to justify a modification of the statement that the characteristic color of the system is brown or brownish red.

The more compact sandstone is quarried at a large number of localities throughout the system, and is extensively used for architectural purposes in nearly all of the cities of the Atlantic coast. The reports on building stone mentioned in the footnote on page 32, give detailed information in this connection.

When the sandstones are examined under the microscope they reveal the fact that they are composed of a great variety of mineral and rock fragments, but in the main are formed of grains of quartz, feldspar, and mica. In the rocks having the characteristic ferruginous color, the individual grains are coated with a ferriginous, clayey incrustation, which also cements the particles one with another and imparts its color to the rocks.

It seems probable that the origin of the coloring matter is to be found in the subaerial decay of the crystalline and Paleozoic rocks from which the débris forming the strata were derived.[1]

Some of the strata of the Newark system are fine grained, black, highly bituminous slates. These occur to a limited extent in the Connecticut valley and New Jersey, but are present in great abundance in the Richmond, Deep river, and Dan river areas. In the southern areas these rocks are associated with coal seams, and in some instances pass into black-band iron ore of limited economic value.

LIMESTONES.[2]

The limestones are seldom more than a few feet thick and are mostly confined to a few localities in the Connecticut valley and the northern part of the New York-Virginia area. Very impure limestone, scarcely distinguishable from carbonaceous slates, does occur, however, in connection with some of the coal-bearing strata at the south. These strata are distinct from the marginal calcareous conglomerates, and frequently occur at a distance of several miles from the borders of the system, and are interstratified with shales and fine-grained sandstones.

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[1] **Russell, I. C.**: Subaerial decay of rocks and the origin of the red color of certain formations. Bull. U. S. Geol. Surv., No. 52, 1889, pp. 45–56.

[2] **Hitchcock, Edward**: Geol. Massachusetts, Final Rep., 1841, vol. II, p. 444. Percival, J. G.: Geol. Connecticut, 1842, pp. 442–444. Mather, W. W.: Geol. of New York, 1843, p. 288. Rogers, H. D.: Description of the Geol. of New Jersey, Final Report, 1840, p. 134. Cook, G. H.: Geol. of New Jersey, 1868, pp. 214, 215.

They are usually compact, light colored, fine-grained rocks, and are without fossils or other evidence of being of organic origin. Neither do they have the characteristics of chemically formed deposits. In some instances they seem to have originated from the deposition of calcareous mud derived from the erosion of adjacent limestone areas.

COAL.

In the New York-Virginia and more northern areas no coal seams have been found, although the presence of carbonized tree trunks, or other very limited quantities of carbonaceous material, have been reported from time to time as true coal seams. The usual high dip of the strata in the northern areas renders it evident that coal seams would be likely to reveal themselves did they exist. The presence of strata of highly carbonaceous shales in these areas is the only suggestion of the possible presence of coal that the geologist has to offer.

Workable beds of coal have been discovered in the Richmond, Farmville, and Deep river areas. The coal is bituminous except where alteration has occurred, owing to the heat of intruded igneous rocks.

QUALITY OF COAL.

In the Richmond field it is described by Heinrich[1] as being highly laminated, bright black, highly resinous, and composed of thick laminæ in thin layers alternating with dull black laminæ of less dimensions. On the fresh fracture, which is more or less conchoidal, it is jet black, luster resinous and splendent. It splits most readily parallel to the stratification, which is strongly marked by the alternate dark and bright layers.

This description would apply equally well to much of the coal of the Farmville and Deep river areas. As it is seen at the mines, the better grade is bright and compact, and indicates at once that it is a valuable fuel. This general impression is sustained by many tests that have been made, and by the favor with which the coal of the Richmond field, especially, has been received by those interested in gas and other industries in the city of Richmond.[2]

The average composition of eleven samples of coal from as many mines in the Richmond coal field, is given in column I below, and the analysis of an average sample of coal from Farmville, in the Deep river area, in column II.[1]

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[1] The Mesozoic formation in Virginia: Am. Inst. Min. Eng. Trans., vol. VI, 1879, p. 243.

[2] Johnson, W. R.: A report to the Navy Department of the United States on American Coal, Washington, 1844, p. 448. Other analyses may be found in O. J. Heinrich's essay on the Mesozoic of Virginia; Am. Inst. Mining. Eng., Trans., vol. VI, 1879, p. 269.

Average composition of the coals of the Newark system.

	I.	II.
Specific gravity	1.436	....
Water, at 115° C	....	2.15
Sulphur	1.232	3.72
Volatile matter	29.432	28.88
Fixed carbon	58.113	52.56
Ash	10.903	12.69
	....	100.00

NATURAL COKE.

Besides the bituminous coal which is the characteristic fuel deposits of the areas here treated, there are beds of "carbonite," "natural coke," and "semianthracite," which are modifications of the normal coal due to the heat of intruded igneous rocks.[2] Of these the most interesting and important is the natural coke. This occurs both in the Richmond and Deep river coal fields, and is of considerable economic importance. It is iron black in color, porous, has a metallic luster, and resembles artificial coke. It has been mined especially at Carbon hill and Midlothian, on the east side of the Richmond area.

The average of five analyses by various chemists, gives the composition of this substance as follows:

Average composition of natural coke.

Volatile matter	12·50
Fixed carbon	79·93
Sulphur	0·26
Ash	6·55
	99·24

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[1] This and other analysis of the coal of the Deep river area may be found in H. M. Chance's report on an exploration of the coal fields of North Carolina, Raleigh, 1885, pp. 33, 34.

[2] The history of our knowledge of this substance may be traced in the following works: W. B. Rogers: On the porous anthracite, or natural coke of eastern Virginia. In Am. Jour. Sci., vol. XLIII, pp. 175–176. Also in Am. Ass. Geol. and Nat. Proc., 1840, p. 60. Report of the progress of the Geol. Surv. of Virginia for 1840, p. 124.

Johnson, W. R.: [Remarks on the Natural Coke of Virginia.] In Acad. Nat. Sci., Philadelphia Proc., vol. I, 1842, pp. 223–224. Reprinted in The Coal Trade of British America, Washington and Philadelphia, 1850, pp. 155–156. "Natural Coke" from Tuckahoe, Virginia. In a report to the Navy Department of the United States, on American coals; Washington, 1844, pp. 138–151.

Lyell, C.: On the structure and probable age of the coal field of the James river, near Richmond, Virginia. In Quart. Jour. Geol. Soc. of London, vol. III, 1847.

Rogers, W. B.: [Observations on the natural coke of the Richmond coal field, Virginia.] In Boston Soc. Nat. Hist., Proc., vol. V, 1855, pp. 53–56.

Wurtz, Henry: Preliminary note upon the carbonite or so-called "natural coke" of Virginia. In Am. Inst. Min. Eng., Trans., vol. III, 1874–'75, pp. 456–458.

Heinrich, O. J.: The Mesozoic formation in Virginia. In Am. Inst. Min. Eng. Proc., vol. VI. 1877–'78, pp. 244–269.

Chance, H. M.: Report on the North Carolina coal field, Raleigh, 1885, p. 34.

RICHMOND AREA.

The coal seams of the Richmond field are irregular in thickness, and have been greatly disturbed by faulting, as will be explained in the section of this paper devoted to structure. The seams are not continuous throughout the field, although they occur at approximately the same horizon. There is no assurance that the seams worked on one side of the basin are individually the same as those explored on the opposite side, or even in adjacent mines. Seemingly the coal occurs in lenticular beds, the outlines of which have not been determined. The edges of these beds overlap, so that while the series as a whole may be continuous over comparatively large areas, individual beds die out and are replaced by others. What is a thin seam in one mine may thicken and become the most important bed in an adjacent mine. This hypothesis, it is true, has not been fully demonstrated, but it explains many peculiarities in the field.

In the Norwood mine on the west side of the area the coal is worked by means of "inclines," in which the following section was exposed in 1885:

	Feet.
Sandstone and shale, dipping W. 20 to 25	10 to 200
Coal, with medial partings of shale	5 to 7
Shales	10 to 12
Coal, with medial parting of shale	6

In the neighboring Powhatan mine there are five coal seams, the most important having a thickness at least locally of 7 feet.

The Old Dominion mines, a mile or two south of the Norwood mines, were worked several years ago by means of a shaft, but are now abandoned. At this locality the strata were penetrated to the depth of 125 feet and found to contain three coal seams. The upper one, where it outcropped at the surface, was about 4 feet 6 inches thick, but increased to 12 feet when followed down the dip. The second was from 18 to 24 inches thick near the surface, and increased to 4 feet in the lower part of the mine. The third was struck 4 feet below the second, and contained 3 feet of coal of inferior quality.

The mines of Manakin (Dover), on the west side of the Richmond area, north of the James, were worked for more than 50 years, and a large quantity of coal obtained. They are now abandoned and the shafts are in ruins. The "Sinking shaft" at this locality penetrated over 900 feet of strata, but failed to reach a workable coal seam. F. W. Stone, the former superintendent of this mine, informed me that there were two coal seams in the Dover region. No detailed account of these deposits is available.

Coal has been mined all along the east border of the area and in adjacent local fault basins, and a large amount of data concerning the thickness and association of the local seams is available.

The section at Carbon hill, north of the James, is as follows:[1]

Section at Carbon hill, Virginia.

	Feet.
Recent formation, soil	20
Alternating shales and sandstones	450
Cinders, so-called fire clay	195
Nodula pyrites	15
Shales and sandstones	60
Coke seam { coke, 2′ 4″ coal, 3′ 8″ }	6
Shale and sandstone	50
Coal seam	3
Shale, third seam	17
Coal	4·5
Shale and shale and sandstone, containing 6-inch coal seam, second seam	40
Coal seam, slope seam 8 to 10 feet, first seam	9
Sandstone and slate to supposed granite base	160
	1,032·5

An extremely detailed record of the strata passed through in exploring for coal with a diamond drill at Midlothian, in the central portion of the east border of the field, has been published by Heinrich, in the paper just cited. These explorations passed through 1,518 feet of Newark rocks, and reached the underlying granite. Four coal seams were penetrated, the lowest of which is 570 feet above the granite. The record of the coal-bearing portion of this section is here copied, with some slight verbal changes:

Section at Midlothian, Virginia.

Stratum.	Thickness.		Distance above granite.	
	Feet.	*In.*	*Feet.*	*In.*
Sandstone, arkose, light gray, hard, partially coarse	34	9	566	4
First coal seam, 3′ 6″ coal, 1′ 6″ slate	5	0	571	4
Slate and schistose sandstone, dark gray	6	2	577	6
Sandstone, arkose, light gray, partially schistose	4	3	581	9
Slate, dark gray	8	0	589	0
Sandstone, arkose, gray	9	10	599	7
Second coal seam	1	0	600	7
Slate, gray	9	0	609	7
Sandstone, arkose, gray, hard	9	0	618	7
Third coal seam, divided by slaty bands from 2 to 24 inches	12	0	....	
Sandstone, gray, silicious, and gray slate	10	3	655	4
Fourth coal seam, divided by slaty bands	14	6	....	
Slate, block and argillacions sandstone	4	0	659	4

At Clover Hill, in the southern part of the eastern border of the Richmond area, the character of the coal-bearing strata has been recorded by Fontaine.[1] There are three main coal seams, and four others of less thickness, designated in the section as local. The strata intervening between the lowest coal seam and the granitic floor on which the system rests has not been penetrated. The dip is here to the westward at an angle of about 25 degrees, and the coal beds outcrop at the surface.

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[1] Heinrich, O. J.: The Mesozoic formation of Virginia. Am. Inst. Min. Eng. Trans., vol. VI, 1879, pp. 260, 261.

Section at Clover Hill, Virginia.

	Feet.	Inches.
Coal seam, local (?) 18 inches to	4	0
Sandstone and shale	14	0
Coal seam, local	0	12
Sandstone and shale	12	0
Coal seam, local	0	14
Sandstone and shale	25	0
Coal seam, local	0	18
Sandstone and shale	40	0
Upper bed of main coal	5	0
Shale, of varying thickness	5	0
Main coal, lower bed	13–26	0
Sandstone and shale	40	0
Lower persistent coal bed	4	9
Sandstone and shale, about	250	0
Gneissic floor		

The section here given indicates the character of the coal seams about the border of the Richmond field. In the detached secondary areas along its eastern border the rocks have been so greatly disturbed that it is difficult to obtain reliable record of the strata. It has been stated that the coal seams in these basins were from 40 to 60 feet thick. The high inclination of the beds, however, and such descriptions of the mines as can be found in books or obtained from men who worked in the mines, render it evident that the thickness of the seams has been exaggerated, as will be shown in discussing the structure of the area.

The presence of workable coal beds in the central portion of the Richmond area seems probable, although that region has not been explored. The nearly horizontal position of the rocks over the central area is a promise that the coal, when reached, will be found in a much less disturbed and broken condition than on the borders of the field. The depth at which coal will have to be looked for in the central area is in the neighborhood of 2,500 feet. At present this depth would probably render economic mining impracticable, owing to the low price of coal in neighboring markets.

FARMVILLE AREA.

Coal was formerly worked in this area in a systematic way for several years, but the seams are thin, ranging from 6 to 30 inches, and are greatly disturbed. No definite records of the strata penetrated in the various mining operations are to be had.

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[1] Older Mesozoic Flora of Virginia. U. S. Geol. Surv., Monograph vol. 6, 1883, p. 6.

DEEP RIVER AREA.

There are reasons for considering the Richmond and Farmville areas in Virginia as having been formerly directly connected with the Deep river and Dan river areas of North Carolina. The coal-bearing rocks in the Deep river area have a striking analogy to the medial portion of the section obtained in the Midlothian mines. While it is presumable that the formations are continuous, there is no reason for surmising that the coal seams of one area represent individually the coal seams of the other.

At Egypt, North Carolina, in the central portion of the Deep river area, the section penetrated by what is known as the "Egypt shaft" was carefully recorded by Wilkes.[1] This shaft was 460 feet deep, and ended in black slate just below the lowest coal seam.

Section at Egypt, North Carolina.

	Feet.	*Inches.*
Sandstone (410 feet below surface)	3	0
Black slate	9	0
Coal	4	0
Black band, upper bed	1	4
Coal	1	1
Slate	0	6
Coal	0	7
Black bituminous slate	8	0
Gray sandstone and fire clay	16	0
Black band	1	5
Coal	1	0
Black band	3	0
Black slate	1	0

At Farmville, North Carolina, 2 or 3 miles west of the Egypt shaft, the coal-bearing strata come to the surface but are disturbed by faults and by dikes of igneous rock. The section at this locality, after Chance,[2] is as follows:

Section at Farmville, North Carolina.

	Feet.	*Inches.*
Upper coal (coal 3 feet, shale 2 feet, coal and slate 3 feet)	8	0
Slate and sandy fire clay	17	0
Coal	0	4
Slate and fire clay	6	0
Coal	1	0
Slate and fire clay	4	0
Coal	1	2
Slate and fire clay	4	0
Lower coal	2	0

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[1] [Report on the Deep river country in North Carolina.] 35th Congress, 2d session. Senate Ex. Doc. No. 26.

[2] Report on the North Carolina coal fields, to the Department of Agriculture (of North Carolina), Raleigh, 1885, p. 22.

DAN RIVER AREA.

The rocks in this area are similar in nearly every respect to those of the Deep river area, but the shaly slates in the central portion of the series are thicker and perhaps of greater extent. They contain many bands of black bituminous and carbonaceous layers, which have been frequently mistaken for coal.

This area has been critically examined by Chance,[1] who reports that the coal occurs merely as sporadic deposits of limited extent and too thin, irregular, and uncertain to be of commercial value.

COMMERCIAL DEVELOPMENT.

Mr. Heinrich[2] states that coal was discovered in the Richmond area as early as 1700 and was then mined for local use. Systematic mining was begun about 1790. This was the first coal mined for shipment in the United States. The total production of the area from 1822 to 1878 is estimated at 5,647,621 tons. Since 1878 mining has been carried on at Clover Hill and at the Norwood and Powhatan mines, the annual output being about 700,000 tons.

Coal is reported to have been mined in a small way in the Farmville area[3] between 1855 and 1870, but no definite record of the operation is available. I have been informed that mining was resumed in 1890 with a promise of good results.

The coal seams of the Deep river and Dan river areas, like those near Richmond, outcrop at the surface. Coal was dug from open pits, for local use, early in this century, but no systematic mining was carried on until about 1850, when improvements in the navigation of Deep river rendered its shipment practicable. The most active period in the history of this field was just preceding and during the civil war.

When I visited the area in 1885 no mining was being done, although a systematic examination of the value of the coal seams near the Gulf was being made. At Egypt all work had been suspended for fully twenty years, and the deep shaft was in ruins.

In the Dan river area a little coal was mined during the war, for use in Danville.[4]

The reason for the unsatisfactory history of the Newark coal fields lies primarily in the great disturbances that the various areas have suffered on account of tilting, faulting, and igneous intrusions. The presence of "fire damp" in many of the mines and a tendency to spontaneous combustion have also added to the danger and expense of working. In all the fields mining was begun at the surface. Water was thus admitted and the most valuable portions of the beds permanently injured. The lack of foresight in the early development of the mines has practically ruined large areas.

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[1] Report on the North Carolina coal fields to the Department of Agriculture (of North Carolina), Raleigh, 1885, pp. 62–66.

[2] The history of this coal field and a detailed record of the amount of coal produced in various years is given by Heinrich. Am. Inst. Min. Eng., Trans., vol. VI, pp. 266–274.

[3] The history and character of this field and of related coal-bearing areas, is given by S. H. Daddow and B. Bannan, in "Coal, Iron, and Oil, etc," Pottsville, Pa., 1866, pp. 393–406.

[4] The history of these various fields has been summarized by H. M. Chance in report on the coal fields of North Carolina, made for the State Board of Agriculture, Raleigh, 1885, pp. 22–24.

At present the cheapness with which coal can be furnished along the Atlantic border, from the extensive mines on the west slope of the Appalachians, practically closes competition in the mines of the Newark area, where mining is more expensive than in the great fields farther west, owing to the natural difficulties suggested above. Those best qualified to judge of the value of the Richmond field are of the opinion that it contains an important reserve supply of coal which will be utilized in the future.

The value of some of the highly carbonaceous slates associated with the coal, for gas manufacture, indicates that they too will ultimately be used.

The disturbed and broken condition of the rocks here considered precludes the hope that they will ever yield even limited supplies of oil or gas.

THICKNESS OF THE NEWARK ROCKS.

Many estimates have been made of the thickness of the Newark rocks, but owing to the faulted structure that characterizes the system no generally accepted results have been reached. It is possible to measure the thickness in the Danville, Dan river, and Wadesboro areas with a reasonable approximation to accuracy, but this has not been done. The only reliable evidence of the thickness of the system available is the records of various deep borings that have been made.

An artesian well at Northampton, Massachusetts, sunk in the lower sandstone of the system, reached a depth of over 3,000 feet without reaching the underlying crystalline rocks.[1] A well bored near New Haven, Connecticut, by the Winchester Arms Company, approximately 2 miles from the west border of the Newark rocks, reaches a depth of 2,400 feet without passing through the system.[2]

Many wells have been sunk in the Newark area of New Jersey in search of artesian water. The deepest of these is at Paterson and reached a depth of 2,100 feet, all but the upper 6 feet being in the sandstones, shales, etc.[3]

Explorations for coal with the diamond drill at Midlothian, Virginia, near the eastern margin of the Richmond area, reached the underlying granite at a depth of 1,518 feet.[4]

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[1] Emerson, B. K.: (Topography and Geology of Hampshire county, Massachusetts.) In Gazetteer of Hampshire county for 1854–1887. Compiled and edited by W. B. Gray, Syracuse, N. Y. (1888), p. 19.

[2] Hubbard, O. P.: New York Acad. Sci., Trans., vol. IX, 1889–1890, p. 3. It is stated by J. D. Dana that this well shows a depth of Newark rock of at least 3,100 feet. Am. Jour. Sci., 3d ser., vol. XLII, p. 442.

[3] Cook, G. H.: Geol. Surv. of New Jersey. Ann. Rep. for 1885, Trenton, N. J., 1885, p. 115.

[4] Heinrich, O. J.: The Mesozoic Formation in Virginia. In Am. Inst. Min. Eng., Trans., vol. VI, 1879, pp. 256–260.

At Durham, North Carolina, near the west margin of the Deep river area, a well was bored a few years ago to the depth of 1,600 feet, all in rocks of the Newark system.

The data in hand are not sufficient to determine the thickness of rock in the various Newark areas, but it is evident from the records of the Northampton well that an estimate of 4,000 feet could not be considered excessive. When it is remembered that great erosion has taken place, it is evident that the original thickness of the system must have far exceeded the amount just stated.

CHAPTER V.

CONDITIONS OF DEPOSITION.

In the present section, the manner in which the various beds of the Newark were deposited as well as the evidence they contain as to the character of the climate during the time of their accumulation, will be considered.

PHYSICAL CONDITIONS.

PREVIOUS INTERPRETATIONS.

A hypothesis proposed by Rogers,[1] which refers the deposition of the rocks of a large part of the Newark system south of New York to the action of a river rising in the Southern States and emptying into the ocean in the neighborhood of the present site of New York, has met with so little favor and is so inconsistent with later observations that it seems unnecessary to consider it at this time.

The rocks of the Acadian area are considered by Dawson[2] as having been deposited in a bay resembling the present Bay of Fundy, which was swept by strong tides and currents that carried away the argillaceous matter and prevented the deposition of muddy sediments.

In reference to the conditions of deposition of the Newark system in general, Dana[3] observes that the absence of radiates, the paucity of mollusks, and the presence of few species that are properly marine, prove that the ocean had imperfect access, where any, to the regions in which the rocks were deposited. The beds are not seashore formations like the Cretaceous and Tertiary, which goes far to confirm the idea that they are partially estuary and partly of lacustrine origin.

A little later in the same volume Dana states:[4]

> The position of the [Newark] beds on the Atlantic border shows that this part of the continent stood nearly at its present level. The strange absence of marine deposits along the Atlantic border may be accounted for by supposing that the dry land stretched farther out to the eastward, and that seashore deposits were formed which are submerged. A change of level of 500 feet would take a breadth of 80 miles from the ocean and add it to the continent.

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[1] Description of the geology of the state of New Jersey. A final report. Philadelphia, 1840, pp. 115, 166–171. The hypothesis proposed by Rogers is quoted by W. W. Mather in Geol. of New York, part 1, 1843, pp. 289–293, who agrees with Rogers in the main, but ascribes the deposition of the rocks of the Newark system in an inclined position to the meeting of equatorial and polar oceanic currents. The hypothesis proposed by Rogers is dissented from by E. Mitchell in "Elements of Geology, with an outline of the geology of North Carolina," 1842, p. 133.

[2] Acadian Geology, 2d and 3d editions, 1868, 1878, p. 111.

[3] Manual of Geology, 2d ed., 1875, p. 420.

[4] Ibid, pp. 422–423.

In this connection LeConte[1] writes:

> During the Jura-Trias [Newark] the shore line to the north was still beyond what it is now, for no Atlantic border deposit is visible; and along the Middle and Southern States it was certainly beyond the bounding line of Tertiary and Cretaceous, for all the Atlantic deposits of this age have been covered by subsequent strata; and yet, probably not much beyond, for some of these Jura-Trias patches seem to have been in tidal connection with the Atlantic Ocean. It is probable, therefore, that the shore line was a little beyond the present New England shore line, and a little beyond the old Tertiary shore line of the Middle and Southern Atlantic States.
>
> A little back from this shore line, and at the foot of the Appalachian chain, there was a series of old erosion or plication hollows stretching parallel to the chain. The northern ones had been brought down to the sea level, and the tides regularly ebbed and flowed there then as in the Bay of San Francisco or Puget Sound at the present time. In the waters of these bays lived swimming reptiles, Crocodilian and Lacertian, and on their flat, muddy shores walked great bird-like reptiles, and possibly reptilian birds. The more southern hollows seemed to have been been above the sea level, and were alternately coal marshes and fresh-water lakes, emptying by streams into the Atlantic; or, according to Russell, there may have been but one great sound stretching from Nova Scotia to North Carolina, in which the tides flowed and ebbed, the southern end being swampy or marshy. Since that time the coast has risen 200 or 300 feet, and these patches are therefore elevated so much above the sea level.

The physical conditions under which the rocks of the Newark system in New Jersey and the Connecticut valley were deposited, as described by Newberry,[2] are here cited:

> Many of the beds show ripple marks, sun cracks, and rain drop impressions, which prove that they were once beaches or mud flats, sometimes exposed to the air. They are also frequently impressed by the tracks of large and small animals. Everything indicates that these tracks were made by animals that frequented the shores of bays and estuaries where the retreating tide left broad surfaces which were their feeding grounds. Inasmuch as many successive beds show ripple marks, sun cracks, and tracks, the conclusion seems inevitable that the areas where these strata were deposited were slowly sinking and that the land-wash spread by the tide constantly formed new sheets, upon which fresh records were inscribed.

CONCLUSIONS.

The generally accepted conclusions of geologists in reference to the mode of deposition of the rocks under discussion seem to be, that the beds were water laid and must have accumulated in land-locked estuaries and swamps. The suggestion many times advanced that these rocks are lacustral in origin has never been sustained by direct evidence.

The facts on which these conclusions are based may be summarized as follows:

(1.) Absence of characteristic marine or fresh water fossils, thus suggesting brackish water and unstable condition.

(2.) Fossil fishes closely allied to existing ganoids of rivers and lakes, which were, perhaps, migratory in their habits and, like salmon at the present time, were destroyed in large numbers at the mouths of the small streams which they frequented during the breeding season.

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[1] Elements of Geology, 1882, pp. 469–470.

[2] U. S. Geol. Survey, Monograph vol. 14, 1888, p. 5.

(3.) Rapid alternations of sediments which are frequently cross-bedded, and the presence of footprints, raindrop impressions, etc., indicating the prevalence of high tides.

(4.) The presence of land plants in the more carbonaceous portions of the deposit, and of fossil wood in many localities in the sandstone, indicating the proximity of land.

These facts favor the conclusion already stated, that the rocks, especially of the northern portion of the Newark system, were deposited in broad, shallow, tide-swept estuaries, in which broad expanses of mud were left exposed at low water. The southern part of the area of deposition was low and swampy, and received accumulation of carbonaceous matter. A slow subsidence during the period of deposition is shown, particularly in the northern areas, by the occurrence of footprints and raindrop impressions at many horizons.

CLIMATIC CONDITIONS.

Several expressions of opinion have been published respecting the prevailing climatic conditions during the Newark period. I will state the conclusions that have been reached, and then review briefly the evidence on which they rest.

In describing certain coarse deposits on the east border of the Deep river area in North Carolina, Kerr[1] suggested that they indicated a sub-Newark glaciation. But these deposits have been shown by Fontaine,[2] to belong at the end rather than at the beginning of the Newark period. A similar remark was made by Shaler, Davis[3] and Hitchcock,[4] in reference to the origin of the coarse conglomerates of the Newark system in the Connecticut valley.

It has been suggested by Dana[5] that the Connecticut valley had its violent floods during the Newark period, which may have been enlarged by the waters and ice of a semiglacial era.

GLACIAL HYPOTHESIS.

The most extended discussion of the glacial origin of the coarse conglomerates of the Newark system that has been made, is by Fontaine.[6] In order to give an impartial hearing to the hypothesis of Mesozoic glaciation, his conclusion is cited in full:

> I think that many of the features described in the preceding pages can best be explained by supposing that in Triassic and Jurassic times, the Appalachian mountain region was receiving supplies of snow too great to be removed by melting. Consequently the excess must have been discharged by glaciers. These must have advanced and receded more than once in the earlier periods, but did not penetrate to the sea. Toward the close of the Jurassic they advanced in such force that they

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[1] Rep. of the Geol. Survey of North Carolina, vol. I, 1875, p. 146.
[2] Am. Jour. Sci., 3d ser., vol. XVII, 1879, p. 34.
[3] Illustrations of the earth's surface, Glacier, Boston, 1881, pp. 95–96.
[4] Geology of New Hampshire, Concord, 1878, vol. III, Part 3, p. 283.
[5] Am. Jour. Sci., 3d ser., vol. XVII, 1879, p. 330.
[6] Ibid., pp. 236–237.

reached the sea. In the intervening time, while the ice was gathering force, ice rafts, charged with stones and earth, floated down the streams which issued from the foot of the ice. To the frequent pushing forward, and the consequent abrasion of the matter accumulated at the foot of the ice, and in the upper course of the rivers, we must attribute much of the rounded and polished condition of the Potsdam stones now found so far to the east of their original position. This ice may have made its final advance over the whole of the portion of the Atlantic slope in which the features above described are found, or it may have issued from the Blue Ridge, mainly along the line of the Potomac and James, and then in its farther advance to the east have spread laterally, so near the border of the Azoic, as to have coalesced into one sheet. The facts observed rather favor the latter method of advance. From this supposition it would follow that the Mesozoic areas were fed by the cold waters issuing from the ice and snow on the mountains. This may account for the paucity of animal life, especially molluscan life, that they show. The only marine waters with which they could communicate contained forms that could not live in the cold inland waters.

It is probable that the courses of the present principal streams were marked out by this ice action, and hence comes their direct course and independence of the character of the rocks over which they flow. There is no difficulty in explaining the growth of the plants, now found fossil, at a time when the Appalachian mountain belt was covered with snow. All that was needed was a raising of the present winter temperature in the lowlands, for we shall show that for the formation of glaciers on the heights the climate need not have been colder than at present. Owing to the nonexistence of the Rocky mountains, the cold western and northwestern winds of the present time would not by reflection from that chain then reach the eastern slopes. At the same time the greater extension of the Gulf waters northward would cause southerly winds to sweep over these slopes. These winds passing over the cold waters of the lakes and great rivers would form abundant fogs. Thus a mild, equable, and moist climate would be produced in the lowlands, even if the earth had its present amount of cold, causing the growth of ferns, cycads, etc., and covering the hills with the immense growth of coniferous trees which we know must have existed. This condition of things would also be eminently favorable for the production of coal. This was only brought to a close in the final advance of the ice at the end of the Jurassic period, when all the abundant forms of plants of that period were extinguished to appear no more. No other cause seems adequate to explain the total extinction of the Jurassic flora, and the complete change which we find in the succeeding Cretaceous flora.

But while the plants were growing in the lowlands and around the lakes, a very different condition of things prevailed in the high Appalachians. The stratigraphy of the formations composing this belt, and the amount of erosion which, as we know, took place, make it clear that in the early Mesozoic times much of this region must have stood above the snow line, and a still larger portion near it. If we recall the physical features of the North American continent which existed at that time, we shall see that even with our present climate then prevailing, the conditions would have been eminently favorable for the formation of glaciers. Along with a sufficient degree of cold we must have abundance of moisture to produce glaciers. This would be supplied by the western and southwestern winds. The latter would sweep unchecked from the Pacific over vast bodies of warm waters in the interior, and meeting the lofty mountain belt of the Appalachians, would give unlimited supplies of snow. The configuration of this elevated district with its broad slopes, and long valleys inclining in one direction, would be eminently favorable for the collection of snow and its discharge in the form of glaciers. Indeed this region must at that time have formed a perpetual storm center. We are not without evidence, however, that a period of cold greater than that now existing, prevailed toward the close of the Jurassic, and in this we find the explanation of the advance of the ice so far to the east at that time.

The statement has recently been made by J. D. Dana[1] that the Newark period "ended in a semiglacial era, as is admitted by all who have studied the beds." The evidence which is advanced to support this view "consists of thick deposits of stones and bowlders in which occur masses 2 to 4 feet in diameter, and therefore such as only ice could have handled and transported. They are situated along the west side of the area in Virginia, Maryland, and New Jersey (where the dip of the Jura-Trias [Newark] beds is westward),[2] and on the eastern, in Connecticut and Massachusetts (where the dip is eastward). Fontaine has found in Virginia and Maryland that they are the *later beds* of the formation." Beds north of Amherst, Massachusetts, containing bowlders 3 to 4 feet in diameter are referred to, and Edward Hitchcock's conclusion, that they are the upper beds of the series, is cited. Coarse deposits near East Haven, Connecticut, are also mentioned.

The considerations which are thought to maintain the hypothesis of glaciation during the Newark period may be briefly stated as follows:

(1) Presence of coarse conglomerates and breccias at many localities.

(2) Absence of fossil mollusks, radiates, etc.

(3) Unexplained phenomena in the drainage and relief of the Appalachians.

(4) Extinction of the fauna and great changes in the flora of the Atlantic border in the interval between the Newark and Cretaceous period.

Before discussing the value of this evidence let us see what records might reasonably be looked for in case glaciers did assist in the deposition of the Newark sediments.

PRESERVATION OF GLACIAL RECORDS.

All records of glaciation when not buried beneath subsequent deposits would certainly be destroyed by atmospheric decay and erosion during such a vast lapse of time as has intervened between the Newark period and the present day. An exception to this statement may possibly exist in the effects which glaciation might impress upon the drainage and topography of a region. It is possible that some of the seemingly abnormal features in the drainage of the Appalachians may be accounted for on the hypothesis that they are an inheritance from an ancient period of ice invasion.

Among the direct evidences of glaciation which might be preserved for indefinite ages are:

(1) Smooth and striated rock surfaces, characteristic of ice action. Such surfaces if buried beneath fine sediments might be preserved in their original condition; or casts of them might be made, in the same manner that impressions of foot-prints showing the most delicate markings, have been preserved.

(2) Bowlders, smooth and striated and faceted by glaciers, might

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[1] Am. Jour. Sci., 3d ser., vol. XL, 1890, p. 436.

[2] Ibid., vol. XLI, 1891, note of errata.

retain their peculiar markings for an indefinite period, especially when cemented with fine sediment or united by calcareous or other infiltrations..

(3) When a glacier enters a lake or estuary, morainal material is deposited in irregular, unassorted heaps about its foot. The distance seaward to which terminal moraines may be deposited, depends on the size of the glaciers and on the depth of the water bodies they enter. A shallow estuary or lake would offer but feeble resistance to the advance of a glacier, and might have moraines widely distributed over its bottom. On the other hand, a deep water body with precipitous shores, would retard the progress of a glacier or check its advance altogether. The result would be the formation of moraines near the water margin.

(4) When glaciers enter water sufficiently deep the ice breaks off and forms bergs which may transport stone and bowlders to great distances, and finally drop them in the fine sediments that accumulate in deep water.

(5) The effects of a glacial period on animal and plant life has received much attention, but it is difficult to indicate what permanent records of this nature might be expected. A long period of glaciation might revolutionize the fauna and flora of a region, while many alternations of warm and cold climates would produce even greater changes. Luxuriant forests, however, are known to grow close to existing glaciers. not only in tropical and subtropical regions, but in high latitudes, The Malaspina glacier, Alaska, is not only bordered by exceedingly dense forests, but the moraines resting upon its margin are covered over an area of many square miles with dense vegetation, and support forests of spruce trees, many of which are fully 3 feet in diameter. Plants indicating temperate and tropical conditions might easily be preserved in connection with glacial deposits, but such paradoxical records must, for the most part, occur in connection with the deposit of glaciers originating in lofty mountains, and not along the borders of continental glaciers like those that covered the northeastern part of North America during the Pleistocene.

The water into which large glaciers discharge either directly or after melting are cold and could not be inhabited by animals characteristic of tropical conditions. It is in the animal remains found in the fine deposits, intimately associated with glacial accumulations, that we should expect to find the best records of the climatic conditions under which the strata were deposited.

WEIGHT OF THE EVIDENCE OF GLACIATION.

Having in mind what records might reasonably be expected to occur in the rocks of the Newark system if glaciers had assisted in their deposition, let us see what the facts are:

(1) No smooth and striated rock surfaces have been discovered beneath the system.

(2) No glaciated bowlders have been observed in the coarse conglomerate.

(3) The bowlders in the conglomerates are usually rounded and are such as streams, especially if assisted by river ice, could transport. Large angular erratics are conspicuous by their absence.[1]

(4) The coarse material characteristic of portions of the system is confined principally to its bottom and sides. As the fine sediments closely associated with the coarse deposits are frequently ripple-marked and contain footprints and raindrop impressions, it is evident that the water bodies in which these beds were deposited were shallow. The water being shallow, there is no reason why glaciers should invariably stop at the shores and deposit their loads, instead of spreading widely over the basin. Besides, the coarse deposits do not have the heterogeneous character of moraines, but are frequently stratified and show current bedding, as if deposited by strong currents.

(5) Along the outer or seaward margins of the coarse layers they are interstratified with fine sediments which are not crumpled or contorted as would be expected had glaciers invaded the basins in which they were laid down.

(6) No scattered bowlders or large rock fragments, indicating iceberg drift, have been found in the fine sandstones and shales which make up the great bulk of the system.

(7) No fossils that are indicative of a cold climate have been found.

As stated in a previous paper,[2] it is not probable that the great numbers of reptiles, some of them of gigantic size, which lived during the Newark period, could have existed in estuaries that were partially occupied by ice and in which icebergs were floating. Coldblooded animals at the present day are confined to warm regions, and there is no reason to suppose that this law was reversed during the Newark period. The swarms of reptiles that formerly inhabited the Connecticut valley and New Jersey regions must have required a large amount of plant or animal food. This would imply also that the shores of the Newark basin were more like those of Florida than those of Greenland at the present time.

To make more specific objections to the hypothesis of glaciation, it may be remarked that paucity of molluscan life does not necessarily indicate a cold climate, as implied by Fontaine,[3] since, as is well known, many species of shells are found in the mud at the foot of existing glaciers which terminate in the sea. The same and allied species of mollusks occur in the Pleistocene glacial clays of both Europe and America, thus showing that the existence of glaciers is not necessarily attended with the extermination of the lower grades of marine life. Besides, the glacial hypothesis for accounting for the general absence of molluscan life in the Newark system is not the only one in the field; other more or less satisfactory explanations of the same phenomena have been offered, which do not imply an arctic climate.

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[1] Even angular rock masses 20 or 30 feet in diameter are not alone sufficient evidence of glacial action, since such masses occur in alluvial cones in the arid regions 2 or 3 miles from the outcrop from which they were derived.

[2] On the former extent of the Triassic formation of the Atlantic States. Am. Nat., vol. XIV, 1880, p. 710.

[3] Am. Jour. Sci., 3d ser., vol. XVII, 1879, p. 52.

From what has been stated in the last few pages it seems obvious that the only basis that can possibly be claimed for the glacial hypothesis under discussion, is the presence of coarse conglomerate along portions of the borders of the Newark areas. That the character and distribution of this conglomerate are such as would result from the action of waves and currents along a shore from which débris was being derived is seemingly sufficiently upheld by observations to exclude other hypotheses.

As shown elsewhere in this paper the coarse deposits are not confined to the present surface, but occur at the base of the system and interstratified with fine sediments along certain portions of the margins of the existing areas. Furthermore, the fine sediments associated with the coarse deposits are not crumpled or contorted, as would be expected had glaciers ridden over them. The rock masses forming the conglomerate are usually either rounded or subangular, and are such as high grade streams might sweep down into an estuary. Large angular masses like those occurring on many glaciers are notably absent.

In reference to the break in the succession of animal life and the great changes in the flora of the Atlantic coast between the deposition of the Newark beds and the next succeding formation, it is to be remembered that a great unconformity occurs at this horizon which makes a gap in the life records. How long this time was we have no means of judging, unless it is that during the interval the animals characteristic of the Newark become extinct and the flora greatly modified. As is well known, such breaks in stratigraphy are accompanied by equal marked modifications in the life records at many horizons in geological history. To assume that the changes in the flora and fauna between the close of the Newark and the beginning of the next period of which there is any record in the Atlantic coast region are due to a glacial epoch is doing violence to a general rule. Great breaks in stratigraphy are always accompanied by breaks in the life records.

INDICATIONS OF A MILD CLIMATE.

In an essay on the subaerial decay of rocks and the origin of the red color of certain deposits,[1] I have shown that there are reasons for considering the characteristic red color of the rocks of the Newark system as due to the subaerial decay of the débris of which they are composed previous to its deposition. It is also shown in the paper referred to that such decay occurs especially in warm humid regions. The suggestion was also made, as has been done in substance previously by Von Richthofen, that the decay indicated by the character of the material forming the Newark rocks may have occurred in a great measure during the Carboniferous. This hypothesis is not necessarily inconsistent with the hypothesis of glaciation, however, as the accumulated débris resulting from a long period of decay might have been removed and deposited during a subsequent period of glaciation.

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[1] Bull. U. S. Geol. Survey, No. 52.

The plants that have been found in the Newark system are represented at the present time mainly by Araucarian pines, ferns, equiseta, and cycads, thus suggesting a temperate or subtropical climate. Although this flora is not inconsistent with the contemporaneous existence of local glaciers, yet it may be taken as evidence that a decidedly glacial period like that of the Pleistocene did not occur during the time it flourished.

CONCLUSIONS.

The absence of glacial records seems to warrant the conclusion that glaciers did not enter the basins in which the Newark rocks were deposited. . It does not follow, however, that the Appalachians were not occupied by local glaciers. The suggestion that those mountains were higher in the Newark period than now, and were covered with perennial snow, while the adjacent low lands enjoyed a mild climate, seems an attractive and very possible hypothesis, but definite evidence as to its verity has not been obtained. The proof that the climate of the Atlantic slope during the Newark period resembled that of Italy at the present day, with glaciers on the neighboring mountains, must be looked for in the drainage and sculpturing of the mountains, and the character and distribution of the débris washed from them. A period of long decay preceding the birth of the Appalachian glaciers would have prepared land to furnish abundant débris when the facilities for transportation were augmented.

RÉSUMÉ.

In this chapter an attempt has been made to show that the Newark sedimentary rocks including conglomerate, sandstones, and shales were probably deposited in tide-swept estuaries, while the carbonaceous shales and associated coal seams originated in basins more thoroughly shut off from the sea. The carbonaceous deposits are confined to the southern areas, and indicate that subsidence was there less rapid than farther north.

The eastern borders of the Newark estuary can only be determined in part; portions of an eastern shore are preserved in the Connecticut valley, and course conglomerates on the east side of the Deep river area seem to show that there was land to the eastward in that region, as has been suggested by Kerr. Further than this, the facts in hand do not warrant definite conclusions.

The climate of the period does not seem to have been marked by extremes. Certainly the evidence indicating glaciation is weak, while the suggestion of a mild climate has many considerations in its favor.

CHAPTER VI.

LIFE RECORDS.

The fossils now known from the system under review comprise two genera of Marsupialoid mammals; a large number of batrachians and reptiles, represented in part by bones and teeth, but principally by footprints; several genera of fishes; a few imperfectly preserved molluscan shells; a small number of insects, known from larvæ and tracks; crustaceans of the genera Estheria and Cladonia, and what are supposed to be the trails of higher forms, and a rich flora containing conifers, cycads, equiseta, and ferns.

The most abundant fossils are footprints and trails impressed upon the strata while in the condition of mud and sand and retained with wonderful fidelity. Records are thus preserved of many animals, some of them of gigantic size, no other relics of which have been found.

MAMMALS.

The mammalian remains thus far discovered consist of the jaws of insectivors, obtained by Emmons[1] at Egypt, in the Deep river area, North Carolina, some fifty years ago. These were described by Emmons under the name *Dronotherium sylvestre*, but have recently been revised by Osborn[2], and shown to belong to two genera, for one of which the name *Microconodon* is proposed. The mammalian remains now known are *Dronotherium sylvestre* Emm., and *Microconodon tenuirostris* Osb.

BATRACHIANS AND REPTILES.

The earliest discovery of fossil bones in the Newark system was at Phœnixville, Pennsylvania. The fossils there obtained were determined to be reptilian remains by Isaac Lea,[3] and described by him under the name *Clepsysaurus pennsylvanicus*. Clepsysaurus has since been referred to the *Dinosauria* by E. D. Cope.

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[1] American Geology, part VI. Albany, 1857, pp. 93–96.

[2] Observations upon the Upper Triassic mammals Dronotherium and Microconodon. In Philadelphia Acad. Nat. Sci., Proc., vol. XXXVIII, 1887, pp. 259–363. A new mammal from the American Trias. In Science, vol. VIII, 1886, p. 540. The Triassic mammals Dronotherium and Microconodon. In Am. Phil. Soc., Proc., vol. XXIV, 1887, pp. 109–111, pl. op. p. 111.

[3] Mentioned in Philadelphia Acad. Nat. Sci., Proc., vol. V, 1850–'51, p. 205. Described in Philadelphia Acad. Nat. Sci., Jour., 2d ser., vol. II, 1850–'54, pp. 185–202, pl. 17–19.

The next important discoveries were numerous reptilian teeth and fragments of bones obtained in North Carolina. These were studied by Leidy and Emmons, and descriptions and figures of them published.[1]

The Newark rocks near Phœnixville and Upper Milford, Pennsylvania, also yielded a number of vertebrate fossils, consisting of teeth and fragments of bone, which were studied and classified by Leidy and Lea.[2]

Reptilian bones were also found in the Connecticut valley and described by E. Hitchcock,[3] but these were too imperfect to admit of accurate determination.

Recently, the vertebrate fossils from the Newark rocks of North Carolina and Pennsylvania have been systematically investigated by E. D. Cope,[4] who has revised their classification and added several new names to the list.

One of the most important finds in recent years of Reptilian remains in the Newark rocks was near Manchester, Connecticut. This consisted of the skeleton of an animal 6 or 8 feet long, embedded in the ordinary brown sandstone of the region, which is supposed to have been nearly perfect when discovered, but owing to ignorance of its value, only portions were preserved. These have been described by Marsh[5] under the name *Anchisaurus major*. This was probably one of the reptiles that left their footprints in such abundance on the sandstones of the Connecticut valley, and encourages the hope that these rocks, usually so barren in organic remains, may yield other vertebrate remains in the future. Marsh has published a figure of the hind foot of this fossil, and states that it is nearly related to the animal whose remains were found at Springfield, Massachusetts, and described by Hitchcock[1] under the name of *Megadactylus polyzelus.* Both fossils are referred to the same genus by Marsh.

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[1] Geological Survey of the Midland Counties of North Carolina. New York, 1856, pp. 293–322, pl. 5–8. American Geology, part VI. Albany, 1857, pp. 54–93, pls. 5a, 6a, 8, 10.

[2] Lea, Isaac: [On the finding of fossil reptile bones in a calcareous conglomerate near Upper Milford, Lehigh county, Pa.] In Philadelphia Acad. Nat. Sci., Proc., vol. V, 1852, pp. 171–172. Description of a Fossil Saurian of the New Red Sandstone formation of Pennsylvania, with some account of that formation. In Philadelphia Acad. Nat. Sci., Jour., 2d ser., vol. II, 1850–'54, pp. 185–202, pls. 17–19. Remarks on the teeth of a Sauroid Reptile from near Phœnixville [Pa.]. In Philadelphia Acad. Nat. Sci., Proc., vol. VIII, 1856, pp. 77–78. Abstract in Am. Jour. Sci., 2d ser., vol. XXII, 1856, pp. 122–123. [Remarks on fossils from near Phœnixville, Pa.] In Philadelphia Acad. Nat. Sci., Proc., vol. IX, 1858, p. 149. Leidy, Jos.: [Remarks on fossils found near Phœnixville, Pa.] In Philadelphia Acad. Nat. Sci., Proc., vol. XI, 1859, p. 110.

[3] Ichnology of New England: Boston, 1858, pp. 186–187. Supplement to the Ichnology of New England: Boston, 1865, pp. 39–40, pl. 9.

[4] The writings in which these fossils have been treated are noted below:

[Remarks on extinct vertebrates from the Mesozoic Red Sandstone of Pennsylvania.] Philadelphia Acad. Nat. Sci., Proc., vol. XVIII, 1866, pp. 249–250, 290.

Synopsis of the Extinct Batrachia, Reptilia, and Aves of North Carolina. Am. Phil. Soc., Trans., vol. XIV, 1871, pp. 1–252, pls. 1–14.

Observations on the Reptilia of the Triassic formations of the Atlantic region of the United States. Am. Phil. Soc., Proc., vol. XI, 1871, pp. 444–446.

Observations on the distribution of certain extinct Vertebrata in North Carolina. Am. Phil. Soc., Proc., vol. XII, 1871–'72, pp. 210–216, pls. 1–4.

Synopsis of the Vertebrata whose remains have been preserved in the formations of North Carolina. Report of the Geol. Surv. of North Carolina, vol. I. By W. C. Kerr, Raleigh, 1875. Appendix B, pp. 29–52, pl. 5–8.

Descriptions of extinct Vertebrata from the Permian and Triassic formations of the United States. Am. Phil. Soc., Proc., vol. XVII, 1878, pp. 182–196.

On some Saurians found in the Triassic of Pennsylvania by C. M. Wheatley. Am. Phil. Soc., Proc., vol. XVII, 1858, pp. 231–232.

[Vertebrate fossils of the Triassic beds of Pennsylvania.] In Sketch of the Geology of York County, Pennsylvania. By P. Frazer. In Am. Phil. Soc., Proc., vol. XXIII, 1886, pp. 403–404.

A contribution to the history of the Vertebrata of the Trias of North America. In Am. Phil. Soc., Proc., vol. XXIV, 1887, pp. 228–229, pl. 1, 2.

[5] Notice of New American Dinosauria. In Am. Jour. Sci., 3d ser., vol. XXXVII, 1889, pp. 331, 332.

In studying the records that have been made from time to time of the vertebrate fossils of the Newark rocks, one is impressed by the large number of the genera and species that have been established on very fragmentary remains. It seems, at least to one who is not a paleontologist, that many changes in their classification must be expected when more complete material is in hand. The detached teeth and fragments of bone that have been found, however, are important in showing that the Newark period had an abundant and varied batrachian and reptilian fauna. This fact is also manifest from the numerous footprints discovered.

No bones or other remains of birds have been obtained. This, although negative evidence, supports in a measure the conclusion reached by various students of the subject, to the effect that the abundant footprints discovered in the Connecticut valley, New Jersey, and Pennsylvania were made by reptiles.

The batrachians and reptiles from the Newark system now known from fragments of their skeletons are as follows:

Name.	Localities.
BATRACHIA.	
Eupelor durur Cope	Phœnixville, Pa.
Pariostegus myops Cope	North Carolina.
Dictyocephalus elegans Leidy	Do.
REPTILIA.	
Anchisaurus major Marsh	Manchester, Conn.
Belodon pirscus Leidy	Emylsville and Phœnixville, Pa.
B. caroliniensis Emm	Egypt, N. C., Emylsville, and Phœnixville, Pa.
B. leaii Emm	Do.
B. lepturus Cope	Egypt, N. C., and Phoenixville, Pa.
Paleosaurus frazerianus Cope	Emylsville, Pa.
Suchoprion cyphodon Cope	Do.
S. aulacodus Cope	Do.
Clepsysaurus pennsylvanicus Lea	Phœnixville, Pa.
C. beatleianus Cope	Emylsville, Pa.
Palaeoctonus appalachianus Cope	Do.
Thecodontosaurus gibbidens Cope	Do.

FISHES.

A monograph by Newberry, on the fossil fishes of the Newark system, has recently been published, which contains all the information obtainable on the subject and renders it unnecessary at this time to refer to the works of previous writers in this connection. In the work referred to twenty-eight species of fossil fishes are described and referred to seven genera. The works of previous authors, including those of Emmons, W. C. Redfield, J. H. Redfield, and others, have been revised and a large amount of new material added. This important monograph places our knowledge of the fossil fishes of the Newark system on an equality with, if not in advance of, that of any other rock series in this country.

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[1] Supplement to the Ichnology of New England. Boston, 1865, pp. 39-40, pl. 9.

The fossils described and illustrated by Newberry were obtained from Boonton, New Jersey, Durham, Connecticut, and Turner Falls, Massachusetts. They occur for the most part in fine grained black shales, and are to be looked for anywhere in the Newark system, where rocks of this description occur. The localities now known from which fossil fishes have been obtained in greater or less abundance in the system under review are as follows: Clover Hill and Maniken, Virginia; Phoenixville, and Yerkes, Pennsylvania; Boonton, Pompton Furnace, Weehawken, Shady Side, Field's copper mine (near Dunellen; this locality is in Washington valley, 2 miles northwest of Dunellen, and is probably referred to as "Plainfield" by Newberry), and Washington Crossing (8 miles above Trenton), New Jersey; Durham, Westfield, Middlefield, Glastonbury, Middletown, Berlin, and Southbury, Connecticut; Amherst, Chicopee Falls, Hadley Falls, Middletown, Sunderland, Turner Falls, Deerfield, and West Springfield, Massachusetts.

All of the fossil fishes thus far discovered at these localities are Ganoids, and, with one exception, have small rhomboidal scales and belong to the order Lepidosteidæ. The exception is Diplurus, described by Newberry, which is referred to the order Crossopterygidæ.

The genera and species now known from these rocks are as follows:

Fossil fishes of the Newark system.

Name.	Locality.
Acentrophorus chicopensis Newb	Massachusetts.
Catopterus redfieldi Egt	New Jersey (?), Connecticut, Massachusetts (?).
C. anguilliformis W. C. R.	New Jersey, Connecticut, Massachusetts (?).
C. gracilis W. C. R.	New Jersey, Connecticut.
C. minor Newb	Connecticut.
C. ornatus Newb	Do.
C. parvulus W. C. R	New Jersey, Connecticut, Massachusetts.
Dictyopyge macrura Egt	Virginia.
Dipturus longicaudatus Newb	New Jersey, Connecticut.
Ischypterus agassizii W. C. R	New Jersey, Connecticut, Massachusetts.
I. alatus Newb	New Jersey.
I. braunii Newb	Do.
I. elegans Newb	Do.
I. fultus Ag	New Jersey, Connecticut, Massachusetts.
I. gigas Newb	New Jersey.
I. latus J. H. R	New Jersey, Connecticut.

Fossil fishes of the Newark system—Continued.

Name.	Locality.
I. lenticularis Newb	New Jersey.
I. lineatus Newb	Do.
I. macropterus W. C. R	Connecticut.
I. marshii W. C. R	Massachusetts.
I. micropterus Newb	New Jersey, Connecticut, Massachusetts.
I. minutus Newb	Do.
I. modestus Newb	New Jersey.
I. ovatus W. C. R	New Jersey, Connecticut, Massachusetts.
I. parvus W. C. R	New Jersey, Connecticut (?), Massachusetts.
I. robustus Newb	New Jersey.
I. tenuiceps Ag	New Jersey, Connecticut, Massachusetts.
Ptycholepis marshii Newb	Connecticut.

INSECTS.

The presence of insect life in the Newark period is recorded by the larva of a certain insect in considerable numbers in the rocks of the Connecticut valley, and by numerous trails and minute footprints on the glossy surfaces of certain strata in the same region. The larva referred to has been found at Turner Falls, Massachusetts, and was figured by Hitchcock[1] under the name *Mormolucoides articulatus*. It has been more recently described and figured by Scudder,[2] who concludes that it is probably the larva of a *Sialidan neuropteron*, and remarks that it has special interest from the fact that it is the oldest insect larva known.

In "The Ichnology of New England" the footprints of insects are included under one head with those supposed to have been made by crustaceans and myriapods, but in the "Supplement to the Ichnology of New England" they stand by themselves and include twenty-four species referred to eight genera. Some of these are illustrated by photographs by Hitchcock, and others are shown in a similar manner by Deane[3] in his beautifully illustrated work on the footprints of the Connecticut valley.

The classification proposed by Hitchcock for these delicate impressions is based wholly on the footprints themselves, and would no doubt be greatly modified if additional data were obtained. The markings are of great value, however, and record faithfully that there was an abundance of invertebrate life on the shores where the gigantic reptiles of the Newark period made their home.

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[1] "The Ichnology of New England," pp. 7-8, pl. 7.

[2] The oldest known insect larva, *Mormolucoides articulatus*, from the Connecticut river rocks. In Boston Soc. Nat. Hist., Mem., vol. III, 1886, pp. 431-438, pl. 45. Republished in the Fossil insects of North America. New York, 1890. 4to, vol. I, pp. 323-330, pl. 19.

[3] Ichnographs from the sandstone of the Connecticut river. Boston, 1861. Pls. 40-41.

CRUSTACEANS.

In the fine black shales and slates, and sometimes in the reddish brown shales accompanying the coal seams of the Deep river, Dan river, and Richmond areas, are great numbers of small crustaceans, belonging to the genera Estheriæ and Candonia (cypridæ). The same fossils occur in abundance in the black shale at Phœnixville, Pennsylvania, and in the similar rocks beneath the Palisades in New Jersey. They have recently been found also by Nason[1] at many other localities in New Jersey, and are thought by him to belong to certain definite horizons, and therefore to be of value in deciphering the structure of the system. The occurrence of these fossils throughout a wide range in the fine grained strata at the south, has led the present writer to doubt their value in determining special horizons, and indicates that they may be expected almost anywhere in the system where fine grained rocks occur.

These fossils attracted the attention of the pioneer geologists of the Eastern states, and were described in part by Rogers, Lyell, Lea, Emmons, and others; but the most systematic and exhaustive study of them that has been made is by Jones.[2] In the important monograph by this author the descriptions and discussions of previous writers are reviewed, and the fossils themselves described and illustrated. The several genera and species proposed by previous writers are shown to belong to a single species of Estheriæ and two species of Cadonia (?). The classification of these fossils as it now stands is as follows: *Estheria ovata* Lea (including the *Posidonomya minuta*, of Rogers and Lyell; *Posidonia* Lea; *P. parva* Lea; *P. ovalis* Emm.; *P. multicostata* Emm.; *P. triangularis* Emm.); *Candona* (?) *rogersi*, Jones (including the *Cypris*, of Rogers, Leidy and Wheatley, and *Bairidia* and *Cypris*, of Emmons); *Candona* (?) *emmonsii* Jones (including the granulated species of *Cypris*, mentioned by Rogers and Wheatley). Full references to the writings of previous authors on these fossils will be found in the monograph just cited.

Besides the cases of minute crustaceans referred to above, fragments of a shell of *Limulus* and of other crustaceans have been reported by Wheatley[3] from the black shales near Phœnixville, Pennsylvania, but these remains seem to have been too imperfect to admit of more than a provisional classification.

Among the numerous tracks discovered on the sandstone of the Connecticut valley, there are a number which seem to have been made by crustaceans, some of them of large size, as was determined by Hitchcock. Several illustrations of these footprints are given by

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[1] Geol. Surv. of New Jersey, Ann. Rep. for 1888, pp. 28–30.

[2] A Monograph of the Fossil Estheriæ. Paleontographical Society, London, 1862. 4to. Pp. 84–89, 124–126, pl. 2.

[3] Remarks on the Mesozoic red sandstone of the Atlantic slope, and notice of the discovery of a bone-bed therein at Phœnixville, Pa., in Am. Jour. Sci., 2d ser., vol. XXXII, p. 43.

Hitchcock in his work on Ichnology. From the meager records left by these animals, it is manifest that we must wait for further evidence before their place in the zoological series can be assigned.

MOLLUSKS.

Molluscan remains are exceedingly rare in the rocks of the Newark system. The earliest record of the supposed occurrence of a shell is by E. Hitchcock, jr. The fossil referred to was found in the coarse sandstone of Mount Tom, Hampshire county, Massachusetts, and was thought by its discoverer to be allied to the *Rudistæ* of Lamarck, but the fossil was so imperfect that even its family relations could not be assigned with confidence. From the description and the rude figure published by Hitchcock,[1] it seems doubtful if the object referred to can even be classed among mollusks. Even if it is a shell, as supposed, its imperfect condition and the fact that no other specimens have been found, deprive it of nearly all taxonomic value. It was used by Hitchcock,[2] however, as evidence of the post-Triassic age of the rocks in which it was found.

Two species of *Astarte*, from near Washington, Middlesex county, New Jersey, were described as being from the rocks now under discussion, by T. A. Conrad,[3] but the rocks in which they were found have been shown by Whitfield[4] to belong to the Raritan clays, which are classed by McGee[5] in the Potomac formation. Conrad has also described a fossil shell, *Solemya triasina*,[6] from near Perkiomen creek, which empties into the Schyulkill near Valley Forge, Pennsylvania, and still another, the *Myacites pennsylvanicus*,[7] from Phœnixville, Pennsylvania.

Lewis[8] announced in 1884, the discovery of five distinct species of lamellibranchs at Phœnixville, Pennsylvania. Two of these are Unios somewhat resembling *U. calceolus* and *U. lanceolatus*, of Lea; the others were marine forms. In order to complete the record certain doubtful references of fossil shells to the Newark rocks may be mentioned. Isaac Lea[9] found small gasteropod shells in calcareous conglomerate, but those were probably in fragments of Silurian limestone contained in the conglomerate. Another discovery referred with doubt to this system, was made by W. M. Gabb,[1] at Warm Springs, Virginia; we now know that the beds at that locality are much older than the Newark.

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[1] A new fossil shell in the Connecticut river sandstone, in Am. Jour. Sci., vol. XXII, 1856, pp. 239–240.

[2] Ichnology of New England, pp. 6–7, pl. 5.

[3] Descriptions of and references to Miocene shells of the Atlantic slope, and descriptions of two supposed Cretaceous species, in Am. Jour. Conch., vol. IV, 1868, p. 279.

[4] Brachiopoda and Lamellibranchiata of the Raritan clays and greensand marls of New Jersey; U. S. Geol. Surv., Monograph vol. IX, 1886, pp. 22–27.

[5] Three formations of the Middle Atlantic slope, in Am. Jour. Sci., 3d ser., vol. XXV, 1888, pp. 136–137.

[6] Descriptions of new fossil Mollusca, principally Cretaceous, in Am. Jour. Conch., vol. V, 1870, p. 102.

NOTE.—From the arrangement of this article it would appear that three other fossils, one of them from Haddenfield, N. J., were also referred to the Newark system, but it does not seem as if this could have been Conrad's intentions. I. C. R.

[7] Description of new species of Myacites, in Philadelphia Acad. Nat. Sci., Proc., vol. IX, 1857, p. 166, vol. XII, plate.

[8] Science, vol. III, p. 295.

[9] Phil. Acad. Nat. Sci., Jour. n. s., vol. II, 1853, p. 194.

The nearly complete absence of molluscan fossils and the total absence of sponges, corals, and other life records characteristic of oceanic conditions, as well as the discovery of Unios by Lewis is evidence that the waters in which the Newark beds were deposited were not in open communication with the ocean.

FOOTPRINTS.

Footprints in sandstone and shale have been found at a large number of localities in the Connecticut valley, New Jersey, and Pennsylvania. In the areas south of Pennsylvania no records of this character have yet been discovered. The numerous localities in the Connecticut valley in which footprints have been obtained are indicated in part on the map accompanying Hitchcock's work on Ichnology. In New Jersey these fossils have been found at New Vernon, Whitehall, Pompton Furnace, and Boonton, Morris county; underneath the Palisades at Weehawken, in Washington valley near Plainfield, near Princeton; and at Milford and Tumble station on the Delaware. The localities that have yielded the most abundantly are Whitehall and Milford.

In Pennsylvania fossil footprints were found many years ago and described by Lea.[2] More recently they have been found by Wanner[3] in considerable numbers, at Goldsboro, York county. Many of the footprints from New Jersey and Pennsylvania have been examined by C. H. Hitchcock, and found to belong to the species which occur in the Connecticut valley.

The history of the discovery of footprints in the Connecticut valley is well known and does not require more than brief mention at this time. The chief works on the subject are indicated below,[4] and in these references will be found to earlier publications.

In Hitchcock's great work on the Ichnology of New England, and in the supplement that followed, the footprints of more than one hundred distinct species of animals, some of them of gigantic size, were described and named. In this investigation the footprints alone were available for study, and on them a detailed classification was based. In this classification the footprints are referred to animals ranging from marsupialoid mammals, through birds, batrachians, lizards, turtles, crustaceans, myriapods and insects to annelids. There are besides certain peculiar markings which are supposed to have been made by fishes. In addition to the records of animal life, the surfaces bearing the footprints are frequently pitted with raindrop impressions, beautifully corrugated with ripple marks, and covered with a network of intersecting shrinkage cracks.

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[1] Phil. Acad. Nat. Sci., Jour., vol. IV, 1860, p. 307.

[2] Philadelphia Acad. Nat. Sci., Proc., vol. VIII, 1856, p. 8.

[3] Annual Report of the 2d Geol. Surv. of Pennsylvania, for 1887, Harrisburg, 1889, pp. 31–35.

[4] Hitchcock, E.: Ichnology of New England, Boston, 1858, 4to, pp. I–XII, 1–220. pls. 1–60. Supplement to the Ichnology of New England, Boston, 1865, pp. I–X, 1–96, pls. 1–20. Deane, J. Ichnographs from the sandstone of the Connecticut river. Boston 1861, 4to, pp. 1–61, pls. 1–46.

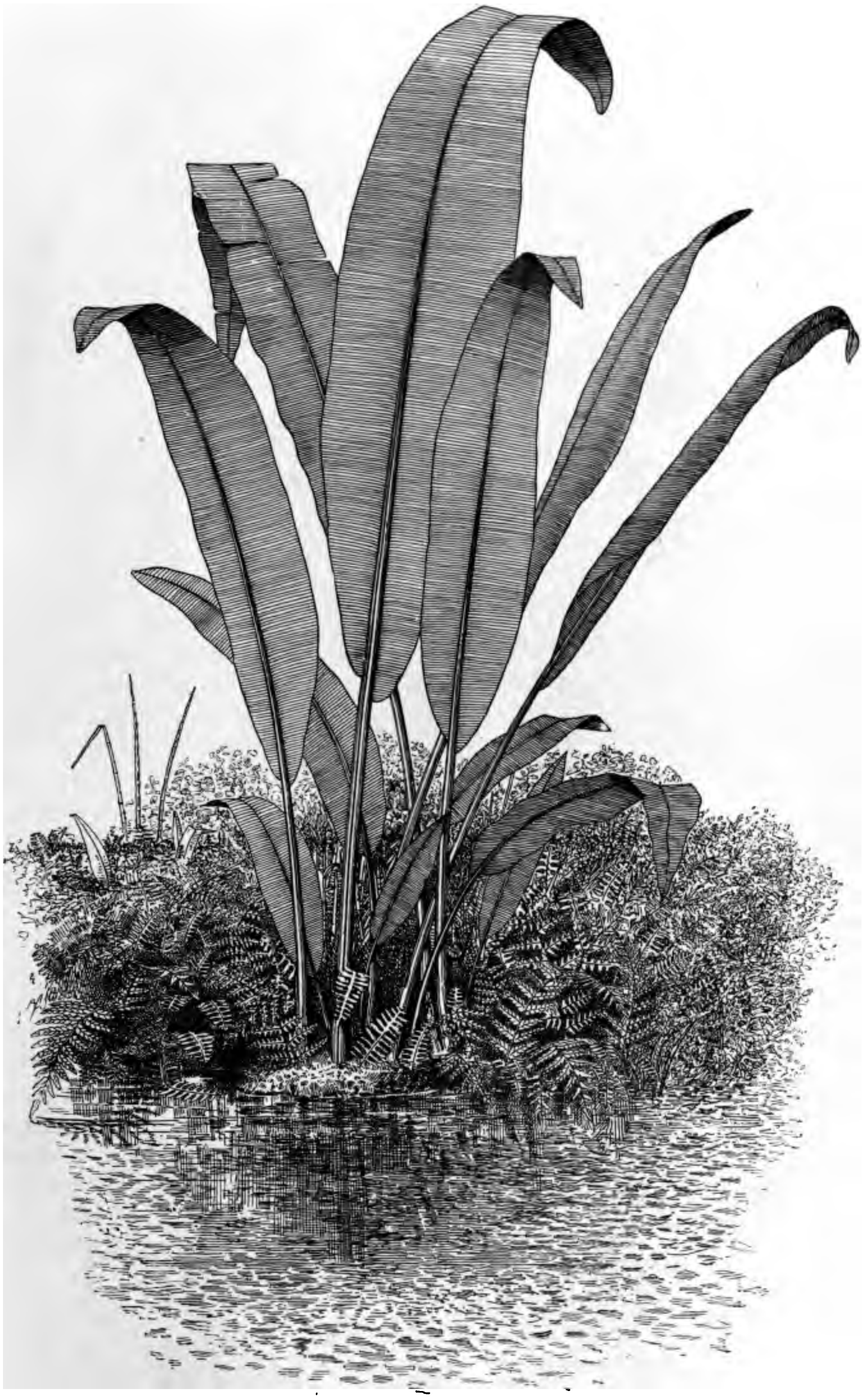
The majority of the tracks discovered by Hitchcock have three toes, and were supposed by him to have been made by birds. This conclusion has subsequently been greatly modified owing to the fact that four and five toed tracks have been discovered in such relation to the three-toed ones, as to show that the animals that made them were four footed. The true ornithic character of any of the tracks can not be considered as proved, and the opinion now prevails among those best qualified to judge in such matters, that the greater part of the tracks were made by reptiles and amphibians.

PLANTS.

Fossil plants have been found in several of Newark areas, from the Connecticut valley southward, but they occur in greatest abundance in connection with the coal seams of the Richmond and Deep river areas. In the Connecticut valley they have been found sparingly at Turner Falls and Sunderland, Massachusetts, and at Durham, Middletown and Portland, Connecticut. In New Jersey they occur in small numbers at Newark, Milford, Boonton, and a few other less important localities. In Pennsylvania a few have been found at Phœnixville, Guynedd, and Goldsboro. In the Richmond area they occur in great abundance at Clover Hill, and have been found at Midlothian and Manikin, Deep run, etc., where fine dark slates occur. They have been found also in the Farmville area, but no considerable collections have been made there. In the Deep river area they are abundant in the fine slates associated with the coal deposits near Egypt, and were found also by Emmons in considerable numbers near Locksville, in a dark slate intimately associated with coarse conglomerate.

In the northern areas the plant remains are largely in sandstone, and consist usually of the more durable portions of plants which could withstand long transportation. At several places in the Connecticut valley and New Jersey they consist of stems deprived of their leaves and bark and scattered through the sandstone. In such cases it is evident that they have been subjected to long transportation, and swept into the areas of deposition from neighboring highlands. In the south, however, the conditions in the majority of instances were different, the plants were preserved where they grew, and even the most delicate fronds were faithfully preserved. In some of the sandstone areas the silicified trunks of trees are preserved in considerable numbers. One of the most important localities is at Germantown, at the southern end of the Dan river area. Similar silicified trunks have also been found at Manassas, Virginia, and in Massachusetts.

Obscure vegetable remains from the Connecticut valley were described principally by Hitchcock, but were too imperfect to be of much value. The plants of the Richmond coal field attracted the attention of Rogers



MACROTÆNIOPTERIS MAGNIFOLIA.

and of Lyell, while those of North Carolina were described and illustrated by Emmons.

A few plants from the Richmond coal field found their way to Europe and were described in the classic works of Schimper and Brongniart. Recent studies of these fossils, however, have carried our knowledge of them far beyond the early attempts, and in the monographs of Fontaine[1] and Newberry[2] is contained our present knowledge of this flora.

In Fontaine's monograph descriptions and figures are given of forty-two species of fossil plants from the Richmond coal field, and it is supplemented by descriptions of about the same number from North Carolina by Emmons. The contributions to this flora from the localities mentioned in New Jersey and the Connecticut valley are few in number and consist principally of the leaves of cycads. The plants thus far found include conifers, cycads, equiseta, and ferns, besides a few species the relations of which have not been definitely determined. The most characteristic and at the same time the most abundant is a magnificent broad-leafed fern, referred to the genus *Macrotæniopterus*. The appearance of this beautiful plant as it grew beside the still waters of the ancient swamps of Virginia, is shown in Plate VIII. This restoration has the approval of Fontaine, and may help to render more real the usual fragmentary records from which our knowledge of this ancient flora is derived. The luxuriant subtropical vegetation of the lowlands of Virginia during the Newark period has its nearest analogue to-day in the silent fern forests of New Zealand. In Virginia the ground must have been thickly covered with lowly ferns, above which rose the graceful bending equiseta and those ferns which had broad, palm-like fronds. On the drier ground grew the stiff-leafed cycads with their immense cones. The uplands must have been clothed with a dark forest of pine resembling the beautiful Auracaia now growing in certain of the South Sea islands. This beautiful flora, which to us seems so strange, probably covered all the region adjacent to the basin in which the Newark rocks were being deposited. In the swamps of the South where the conditions were most favorable for its preservation abundant records were preserved, but in the North only occasional fronds and water-worn trunks were deposited in the accumulating sands.

The plants now known from the Newark system are indicated in the following list. In making this catalogue the works of Fontaine and Newberry have been followed, but Fontaine's monograph has recently been reviewed by Stur,[3] and many of the plants described in it identified with those of the Lettenkohlen of Germany. Should these identifications prove correct many of the names given in the list will have to be changed.

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[1] U. S. Geol. Surv., Monograph vol. 6, 1883.

[2] U. S. Geol. Surv., Monograph vol. 14, 1888.

[3] Die Lunzer-(Lettenkohlen-) Flora in den "older Mesozoic beds of the Coal Fields of Eastern Virginia." In Verhandlungen der K. K. geologischen Reichsanstalt, No. 10, 1888, pp. 203–217.

Plants from the Newark System.

Name.	Locality.
CONIFERÆ.	
Araucarites carolinensis	North Carolina.
Baiera multifida	Connecticut valley, North Carolina, Virginia.
B. münsteriana	Connecticut valley, North Carolina.
Pachyphyllum brevifolium.	Connecticut valley, New Jersey.
P. münsteri	Connecticut valley, New Jersey, Virginia.
P. peregrinum	North Carolina.
P. simile	Connecticut valley, New Jersey.
Palissya ——	New Jersey.
Palissya ——	North Carolina.
P. carolinensis	Do.
P. diffusa	Do.
ZAMIEÆ AND CYCADEÆ.	
Ctenophyllum braunianum, var. a.	North Carolina, Virginia.
C. braunianum, var. B	North Carolina.
C. emmonsi	Do.
C. giganteum	Virginia.
C. grandifolium	Do.
C. lineare	North Carolina.
C. robustum	Do.
C. taxinum	Do.
C. truncatum	Virginia.
Cycadites acutus	North Carolina.
C. longifolius	Do.
C. tenuinervis	Virginia.
Cycadinocarpus chapini	Connecticut valley.
Dioönites longifolius	North Carolina, New Jersey.
Otozamites brevifolius	Connecticut valley.
O. carolinensis	North Carolina.
O. latior	Connecticut valley.
Podozamites emmonsi	North Carolina, Virginia.
P. tennistriatus	Virginia.
Pterophyllum, affine	
P. decussatum	North Carolina, Virginia.
P. inæquale	Virginia.
P. pectinatum	North Carolina.
P. spatulatum	Do.
Sphenozamites rogersianus.	North Carolina, Virginia.
Zamiostrobus virginiensis.	Virginia.
Z. emmonsi	North Carolina.
EQUISETEÆ.	
Calamites arenaceus	Virginia.
Equisetum arundiniforme.	Do.
E. meriani	Connecticut valley.
E. rogersi	North Carolina, New Jersey, Virginia.
Schizoneura planicostata.	Connecticut valley, New Jersey, Virginia.
Schizoneura, sp.?	Virginia.
S. virginiensis	Do.
FILICES.	
Acrostichides densifolius.	Virginia.
A. ægyptiacus	North Carolina.
A. linnææfolius	North Carolina, Virginia.
A. microphyllus	Virginia.
A. rhombifolius	North Carolina, Virginia.
A. rhombifolius, var. rarinervis.	Virginia.
Actinopteris quadrifoliata.	North Carolina.
Asterocarpus penticarpas.	Virginia.
A. platyrachis	North Carolina, Virginia.
A. virginiensis	Virginia.
A. virginiensis, var. obtusiloba.	Do.
Asplenites rösserti	North Carolina,
Cladophlebis auriculata	North Carolina, Virginia.
C. microphylla	Virginia.
C. obtusiloba	North Carolina.
C. ovata	Virginia.
C. pseudo-whitbiensis	Do.
C. rotundiloba	Do.
C. subfalcata	Do.
C. platyphylla	Connecticut valley, New Jersey, Virginia.
C. platyphylla, var. expansa.	Virginia.
Dicranopteris, sp?	Do.
Lacopteris emmonsi	North Carolina.
L. carolinensis	Do.
L. elegans	Do.
Lonchopteris oblongus	Do.
L. virginiensis	Virginia.
Macrotæniopteris crassinervis.	Do.

Plants from the Newark System—Continued.

Name.	Locality.	Name.	Locality.
FILICES—continued.		FILICES—continued.	
M. magnifolia	North Carolina, Virginia.	P. reticulata	North Carolina, Virginia.
Mertensides bullatus	North Carolina, Virginia.	Sagenopteris rhoifolia	North Carolina, Virginia.
M. distans	Virginia.	PLANTS OF UNDETERMINED RELATIONS.	
Pecopteris rarinervis	North Carolina, Virginia.	Dendrophycus triassicus	Connecticut valley.
Psuedodanæopteris nervosa.	North Carolina, Virginia.	L. simplex	Connecticut valley, Virginia.

Besides the plants catalogued above, a few minor discoveries may be noted: Isaac Lea[1] has recorded the discovery of a single plant resembling *Noeggerathia cuneifolia* Brog., near Phœnixville, Pennsylvania. A fucoid named *Palæophycus limaciformis* Lew., was found by Lewis,[2] at Milford, New Jersey. A stem with markings similar to those of Lepidodendron was found at Belleville, New Jersey.[3]

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[1] Phil. Acad. Nat. Sci., Proc., vol. VIII, 1856, p. 78.
[2] Phil. Acad. Nat. Sci., Proc., vol. XXXII, 1880, p. 293.
[3] Geol. of N. J., Ann. Rep. for 1879, pp. 26–27.

CHAPTER VII.

ASSOCIATED IGNEOUS ROCKS.

Intimately associated with the sedimentary strata of the Newark system in nearly all its various areas, are dikes and sheets of igneous rock. The outcrops of these rocks are everywhere remarkably uniform in general appearance, and have but little variety in their mineralogical and chemical composition. They are classed as basalt and dolerite by petrographers, but have all been known as "trap rocks," a term sufficiently accurate for general use and which will be retained in this paper.

In the various Newark areas trap rock appears in two ways, either as dikes breaking across the sedimentary strata, or as sheets more or less uniformly interbedded with them. The sheets are either extrusive, and were spread out as overflows of lava before the accumulation of the sedimentary strata was completed, and subsequently buried beneath the shales and sandstones of later date; or intrusive, and forced in between the strata after their consolidation.

The trap rocks are not confined to the Newark areas, but, in the form of dikes, occur throughout nearly the entire Atlantic coast plain and in the adjacent Appalachians. The evidence showing that the trap dikes in the crystalline and Paleozoic rocks surrounding the Newark areas are a part of the same great system of dikes and sheets occurring within those areas, will be stated in describing their geographical distribution. The age of the trap rocks and their importance in a general study of the Atlantic coast region, will be considered in the summary at the end of this chapter.

MINERALOGICAL COMPOSITION.

As one sees the traps in the field, they are dense, heavy rocks, having a dull, nearly black color when somewhat weathered, but frequently appear bluish or greenish on fresh surfaces. They appear under two general aspects, compact and vesicular. The former occurs in dikes and sheets, and is frequently columnar, while the latter occurs almost entirely in sheets. The vesicular trap has frequently been changed to an amygdaloid by the filling of its cavities with a secondary mineral.

Determinations of specific gravity and mineralogical analyses of trap rock from various localities, from Nova Scotia to the Carolinas, have shown that they are remarkably similar throughout their entire extent.[1] Their essential elements in an unweathered condition, as shown by E. S. Dana, are pyroxene, labradorite, and magnetite, with occasionally some chrysolite and apatite; chlorite is often present as a result of local change.

It has been shown by Hawes that the feldspar element is not a single feldspar, but labradorite and another mineral having the ratio of andesine.

The iron, in places at least, is uncombined, as has been shown by Van Dyck, and elsewhere appears as magnetite and titanic iron. Among the minerals resulting from secondary alteration are a great variety of zeolites, calcites, etc.

As determined by Iddings,[2] the trap rocks are generally holocrystalline, and formed of lath-shaped basic feldspar, irregular grains and crystals of augite, grains of iron oxide, together with considerable green serpentine or chlorite, which is disseminated through the mass and is evidently the alteration product of a fourth primary constituent. Specimens collected at Orange, New Jersey, where the trap occurs in large, well defined columns, when examined in thin sections, however, were found not to be holocrystalline, but to contain a variable amount of glass base. The large serpentine blotches contain olivine in their centers, the primary mineral from which the serpentine is formed. This rock is in every way identical with many medium grained basalts which have been poured out at the surface in recent times, and should be called basalt. The coarser grained varieties are dolerite, as determined by E. S. Dana. The presence of hornblende as an essential constituent in the trap near Gettysburg, Pennsylvania, has been reported by Frazer.[3]

It has been shown by several petrographers that when the rock is somewhat altered, either during its extrusion, through the action of heated solutions, or by weathering after exposure at the surface, that hydration has taken place and various secondary minerals formed. When the trap rocks are more thoroughly decomposed, they form a tenaceous residual clay, usually yellowish or mottled in color, and showing no resemblance to the rock from which it was derived. In the unglaciated portions of the Newark belt the trap rocks are frequently completely decomposed to a depth of from twenty to fifty feet. Owing to their greater solubility than the adjacent sandstone and shales, they frequently give origin to depressions in the topography of the region they traverse.[1] In the glaciated region the outcropping edges of trap sheets usually stand in bold relief. The difference in their appearance in glaciated and unglaciated regions is due to the fact that while more resistant than the associated strata to mechanical erosion, they are usually much more susceptible to chemical changes.

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[1] Dana, J. D. [Density and composition of Newark Dolerites]: Am. Jour. Sci., 3d ser., vol. VI, 1873, pp. 106–107. Dana, E. S.: Trap rocks of the Connecticut valley. Am. Ass. Adv. Sci., Proc., vol. XXIII, 1874, pp. 45–47. Van Dyck [Native iron in the trap rocks of New Jersey]: Geol. Surv. of New Jersey, Ann. Rept. for 1874, p. 57. Frazer, P.: On the traps of the Mesozoic sandstone in York and Adams counties, Pennsylvania. Am. Phil. Soc., Proc., vol. XIV, 1875, pp. 402–414, 431; Pls. 1–4. Also, Second Geol. Surv. of Pennsylvania, vol. C, 1876, pp. 124–129; pls. 2, 3. Frazer, P.: A Study of the Igneous Rocks. Am. Inst. Mining Eng., Trans., vol. V, 1877, p. 146. On the physical and chemical characteristics of the trap occurring at Williams Point (Lancaster County, Pennsylvania). Am. Phil. Soc., Proc., vol. XVIII, 1880, pp. 96–103, and plate. Hawes, G. W.: On the mineralogical composition of the normal Mesozoic diabase upon the Atlantic border. U. S. Natl. Mus., Proc., vol. IV, 1881, pp. 129–134. Marsters, V. F.: Triassic traps of Nova Scotia. In American Geologist, vol. V, 1890, pp. 144–145.

[2] The Columnar structure in the Igneous Rocks of Orange Mountain, N. J.; Am. Jour. Sci., 3d ser., vol. XXXI, pp. 321–331, Pl. 9.

[3] Am. Phil. Soc., Proc., vol. XIV, 1875. p. 43.

CHEMICAL COMPOSITION.

Numerous analyses of the trap rocks have been made, principally from Connecticut valley, New Jersey, and Pennsylvania. It is not necessary to assemble these analyses here, as they may be found from the following references; but, in order to show the general composition of the rock, the average composition of eight samples of unaltered dolerite from New Jersey and the Connecticut valley, analyzed by G. W. Hawes, is inserted.

Average composition of unaltered dolerite.[2]

	Per cent.
Silica (SiO_2)	52·50
Alumina (Al_2O_3)	14·15
Ferrous oxide (FeO)	9·24
Ferric oxide (Fe_2O_3)	1·96
Manganous oxide (MnO)	0·45
Lime (CaO)	10·03
Magnesia (MgO)	7·48
Chromic oxide (Cr_2O_3)	
Soda (Na_2O)	2·30
Potash (K_2O)	0·69
Phosphoric acid (P_2O_5)	0·14
Titanic acid (TiO_2)	
Water (by ignition, (H_2O)	0·92
Total	99·86

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[1] Bull. U. S. Geol. Surv., No. 52, pp. 15–18.

[2] Analyses of Newark trap rocks may be found as follows:

Cook, G. H.: [Name of analyst not given]. Analyses of trap from many localities in New Jersey; Geol. of N. J., 1868, pp. 215–218.

Tyson, S. T.: Analysis of West Rock, Conn. Am. Jour. Sci., 3d ser., vol. VI, 1873, p. 107.

Allen, O. D.: Partial analysis of trap from near lake Saltonstall, Conn. Am. Jour. Sci., 3d ser., vol. VI, 1873, p. 107.

Mixter, W. G.: Analysis of traps from the Palisades, N. J. Am. Jour. Sci., 3d ser., vol. VI, 1873, p. 106.

Hawes, G. W.: Analyses of trap from West Rock, Wintergreen lake, lake Saltonstall, South Durham mountain, Conn.; Mt. Holyoke, Mass., and Jersey City, N. J. Am. Jour. Sci., 3d ser., vol. IX, 1875, pp. 185-192, 454–457.

Frazer, P.: Discussion of the analyses of trap rock from West Rock, Conn., and from near York, Pa. Second Geol. Surv. of Pa., vol. C, pp. 118–124.

Genth, jr., F. A.: Analyses of trap rocks from Pennsylvania. In Second Geol. Surv. of Pa., vol. C 6, 1881, pp. 94–99, 134. Analyses of trap from Gulf Mills, Pa. Am. Phil. Soc., Proc., vol. XXII, 1885, p. 454. Analysis of trap from Cornwall iron mines, Pa. Ann. Rep. 2d. Geol. Surv. Pa., for 1885, pp. 498–499. Analyses of trap from Williams Point, Lancaster county, Pa. Am. Phil. Soc., Proc., vol. XVIII, 1880, p. 96.

Genth, F. A.: Analysis of trap from near York, Pa. Second Geol. Surv. of Pa., vol. C, 1876, pp. 122–124. Analyses of minerals and rocks from Bucks, Montgomery, and Philadelphia counties, Pa. Second Geol. Surv. of Pa., vol. C 6, 1881, pp. 94–99, 134.

Chatard, T. M.: Analyses of decomposed trap from North Carolina. Bull. U. S. Geol. Surv., No. 52, 1889, p. 18.

CHARACTERISTICS OF TRAP DIKES.

The general trend of the dikes throughout the Newark system and in the surrounding areas is northeast and southwest. Those in the crystalline rocks, as a rule, are narrower than those penetrating sedimentary strata. Where dikes occur in the Newark system a hardening and alteration in color of the adjacent sedimentary beds is noticeable. This change seems to be due directly to a baking of the strata; but in some sandstones, especially at the south, it appears to have resulted from the deposition of mineral matter by heated solution. Observations on the change in color and texture in the strata adjacent to trap dikes and sheets have been summarized by W. M. Davis,[1] who has shown that such alterations are confined to the immediate vicinity of the intrusion. The alterations in color consist frequently in the darkening of the rocks. A reddening is not common, and the fallacy of supposing that the general reddish color of the Newark rocks is due to an alteration in the iron they contain, by the heat of the intruded rocks, is clearly proved.

The observations of the present writer have shown that one of the most common changes in the color of the sandstones and shales adjacent to the trap dikes in Virginia and the Carolinas is an alteration to a deep purple color, which fades out into the normal brownish red tint of the Newark rocks at a distance, usually, of two or three feet. Many times the presence of a dike which is deeply decomposed and does not appear at the surface is indicated by two parallel bands of dark purple shale which define its boundaries. The hardened walls adjacent to the dikes resist weathering more effectually than the dikes themselves, and frequently stand in relief when the dike itself is depressed several feet below the general surface.

In some cases the dikes have a columnar structure at right angles to their walls, indicating the manner in which they were cooled and crystallized. In many instances the borders of the dikes show a fine, cryptocrystalline structure; while the central portion, owing to their cooling more slowly, is coarsely crystalline.

In the deeply decomposed dikes at the south a concentric structure is frequently developed by the decomposition. Rounded bowlders, resulting from disintegration, frequently occur scattered through yellowish clay in dikes that are partially decomposed; but when the alteration is more complete, the characteristics of the original rock entirely disappears and yellowish clay alone remains.

CHARACTERISTICS OF TRAP SHEETS.

The trap sheets interstratified with the sedimentary beds of the Newark system are of two classes, as has been shown especially by W. M.

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[1] On the relation of the Triassic traps and sandstones of the eastern United States. In Mus. Comp. Zool., Harv. Coll. Bull., vol. VII, 1883, pp. 300-302.

Davis: First, contemporaneous sheets, or those formed by the surface eruption of igneous rocks and subsequently buried beneath sedimentary beds; second, intruded sheets or those forced in between the sedimentary strata subsequent to their consolidation.

The contemporaneous sheets are conformable with the stratified beds both above and below, while the intruded sheets, although conformable over large areas, in many instances break across the strata, forming dikes which connect the sheets at various horizons. The contemporaneous sheets have altered the sedimentary beds on which they rest, and are scoriaceous at their upper surfaces. The strata resting upon them are unaltered, and may contain fragments of the underlying trap or extruded scoria, volcanic tuff, and the finer products of eruption known as volcanic ash.

The intruded sheets have metamorphosed strata both above and below, and, cooling under pressure, are more compact throughout than the extruded sheets. They cooled most rapidly at their surface, and hence are compact and cryptocrystalline above and below, while their central portions are usually coarsely crystalline.

These characteristics have been discussed by Davis, in connection with the study of the trap sheets of the Connecticut valley, and have been applied by Darton[1] in the investigation of the trap sheets of New Jersey.

GEOGRAPHICAL DISTRIBUTION.

TRAP DIKES OUTSIDE THE NEWARK AREAS.

The great extent of the series of dikes intersecting the Newark areas and their extension into the surrounding areas of crystalline and paleozoic rocks have already been referred to; but it is only within the Newark areas themselves that the distribution of the traps has been approximately determined. Numerous dikes have been described and mapped in Newfoundland, Nova Scotia, New Brunswick, Maine, Vermont, New Hampshire, and eastern Massachusetts, some of which, it seems probable from the descriptions given, belong to the series which traverse the Newark system, but much study is required before this connection can be determined with certainty.

It has been stated by Hobbs[2] that certain diorite dikes near Boston have generally been considered as post-Newark in age, on account of their lithological resemblance to the diabases of the Connecticut valley.

On the geological map of Connecticut published by J. G. Percival in 1842, several narrow trap dikes, somewhat disconnected, are indicated as traversing the crystalline region outside the Newark area.

The work of the Second Geological Survey of Pennsylvania has shown the presence of several such dikes in crystalline and Paleozoic regions of the eastern part of that State. One of the dikes starting just west of the border of the Newark area, near Holly Springs, Cumberland county, Pennsylvania, runs north with some breaks and irregularities, across Perry county and into Dauphin county, a distance of about 35 miles. Other dikes traversing Paleozoic and crystalline rocks occur in Lancaster county, a little south of the Newark area.

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[1] On the relations of the traps of the Newark system in the New Jersey region. U. S Geol. Survey, Bull. No. 67.

[2] On the petrographical characters of the dike of diabase in the Boston basin. In Mus. Comp. Zool., Harv. Coll. Bull., vol. XVI, 1888, p. 1.

The most remarkable dike in this region, however, begins at the north, in Bucks county, and runs in a general southwesterly direction across Pennsylvania and into Maryland for a distance of 90 miles. This dike has been described and mapped by Lewis.[1] Its northern end is in the Newark system, but throughout the greater part of its course it traverses Silurian and crystalline strata.

Southwest of the southern end of the dike described by Lewis, and possibly a continuation of it, is another dike, more or less broken, the course of which has been traced by S. H. Williams for about 30 miles. This dike, as I have been informed by Williams, is later than any of the associated igneous rocks in the region, and was intruded after the crystalline rocks had their present attitude. Lithologically it is undistinguishable from the characteristic trap rocks of the Newark system. Williams has also traced the course of another dike beginning in the Newark area of Maryland, near the Pennsylvania boundary, and running southward to the Potomac. This dike leaves the Newark rocks about 10 miles north of Frederick, and for the remainder of its course traverses the crystalline area.

In Virginia, west of the southern end of the New York–Virginia area, there are trap dikes of the same character as those mentioned above, which trend a little west of north and cut across the folds of the Appalachians. Again, in the western part of Virginia, on the west side of the great Appalachian valley, several small trap dikes have recently been observed by Darton; specimens from these, examined by Diller, are found in all cases to be closely similar to, and in one instance identical with, those of the Newark system.

Farther north in Virginia and the Carolinas trap dikes outside of the Newark areas are of common occurrence but have not been mapped, and little is definitely known concerning their distribution. In South Carolina the same great system continues southward far beyond the last remnants of the sedimentary beds of the Newark, but still retaining all the geological and lithological characters that distinguish it in the north. The dikes of South Carolina were recognized by Tuomey[2] in his admirable report of 1848, and their relation to the series of similar dikes farther north fully understood. The author cited states that he traced the dikes referred to through Georgia, and as far as the Coosa river in Alabama, and also that the direction of the dikes in South Carolina is exceedingly uniform, varying between 15 and 35 degrees east of north, and that they are but slightly inclined from the vertical. My opportunities for observation in South Carolina, although limited, are sufficient to indicate that Tuomey's conclusions seem in every way correct. The reports of the State geologists of Georgia and Alabama contain brief accounts of trap dikes which are supposed to belong to the series under review. Such observations as have been made in this region show that the dikes are abundant, and probably much more numerous than in the northern part of the Atlantic coast plain. Their southern limit is unknown for the reason that, in common with the crystalline rocks they traverse, they disappear beneath the Cretaceous and Tertiary strata, wrapping around the southern end of the Appalachian mountains.

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[1] A great trap dike across southeastern Pennsylvania. In Am. Phil. Soc. Proc., vol. XXII, 1885, pp. 438–456 and map.

[2] Report Geology of South Carolina, Columbia, S. C., 1848, 4to., pp. 65–68.

This hasty sketch of the extent of the trap dikes outside of the Newark system will serve to show their importance in the geology of the Atlantic slope and suggest future lines of investigation. The length of the series of dikes as now known is about 1,000 miles, and its width, although its eastern border is concealed by more recent geological deposits, and by the ocean, is not less than 200 miles.

TRAP ROCKS OF THE ACADIAN AREA.

The trap rocks belonging to the Newark system in Nova Scotia form a bold mountain ridge extending along the eastern shore of the bay of Fundy from Blomidon southward to Brier island, and also many bold headlands and picturesque islands in and about the basin of Minas and the waters connecting with it. These rocks have been studied by J. W. Dawson, especially, and it is to his well known work on Acadian geology that we owe the greater part of our information concerning them. The trappean mass bordering the bay of Fundy on the east is vesicular below and compact and basaltic above. It is considered by Dawson and Marsters[1] to have been poured out as a subaqueous lava flow. In a general way, at least, it is conformable with the sandstones and shales on which it rests, and dips westward beneath the waters of the bay of Fundy at an angle of about 15 degrees. Its relation to higher stratified beds is not known, as no upper contacts have been seen. The vesicular character of the lower part of the sheet and its marked contrast with the compact basalt forming the upper portion suggests the possibility that they are in reality two separate sheets, the lower one being a contemporaneous overflow, and the upper and intruded sheet of later date.

Many of the isolated trap masses in the Minas basin and elsewhere rest on sedimentary Newark beds, and are probably remnants of an extensive lava sheet. The structure in this region is imperfectly understood, and the possible presence of faults not fully investigated.

On the west side of the bay of Fundy, at the island of Grand Manan, trap rock again appears, which has been referred with more or less doubt to the Newark system.[2]

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[1] Triassic traps of Nova Scotia, Am. Geol., 1890, pp. 140-145.

[2] Geol. Surv. of Canada, atlas sheet, No. 1, S. W., note 7.

TRAP ROCKS OF THE CONNECTICUT VALLEY.

The trap rocks of this area have received greater attention than those of any other similar area, but diversity of opinion still exists as to the method of their occurrence. The history of the geological study of this area has been summarized by Davis[1] and need not be repeated here.

On the accompanying map (Pl. III) the outlines of the trap outcrops are shown as accurately as the scale of the illustration will allow. Those in Connecticut are from Percival's map, with some revisions by Davis, and those in Massachusetts are from a manuscript map kindly furnished by B. K. Emerson. All of the outcrops indicated are edges of trap sheets more or less conformable with the associated stratified rocks. Trap dikes are seldom seen and are too small to appear on the maps.

Davis's studies have shown that by far the larger part of the trap sheets were formed by overflows of volcanic rock during the deposition of the Newark strata. The trap sheet in the extreme northern part of the Newark area, near Turner's Falls, Massachusetts, is of this nature, and so also is the great trap sheet following Mount Holyoke and Mount Tom and extending southward as far as Meriden, Connecticut. The conclusion that this trap sheet was extruded at the surface and subsequently buried was advanced by Hitchcock during his survey of Massachusetts, and has since been sustained by Davis and Emerson.

Numerous trap ridges in the eastern part of the Newark area in Connecticut have also been shown by Davis to be extruded sheets, while the intruded sheets are confined to the western border of the area south of Massachusetts. This series begins at the south, at East Rock; a conspicuous bluff North of New Haven appears also in West Rock and forms the long broken ridge running northward. The same series of intruded sheets appears to outcrop again in the Barndoor hills of Granby, on the northern border of the state.

All of the trap sheets of Connecticut were considered as of intrusive origin by Percival, and his conclusion seems to have been accepted by all subsequent writers until Davis's study showed that there were strong reasons for believing that some of the sheets were extrusive and not intrusive. This opinion, although sustained by a large mass of the evidence, is not accepted by all students of the subject, and more detailed work evidently remains to be done before a final and generally accepted conclusion will have been reached. The trap sheet at Tariffville, Connecticut, has been shown by Rice[2] to be of extrusive origin.

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[1] On the relation of the Triassic traps and sandstones of the eastern United States. In Mus. Comp. Zool., Harv. Col., Bull. vol. VII, 1883, pp. 279-281.

The structure of the Triassic formation of the Connecticut valley, in Seventh Ann. Rep. U. S. Geol. Surv., 1885-86, pp. 455-490, Pl. 52.

The lost volcanoes of Connecticut. Pop. Sci. Mo., vol. XL, 1891, pp. 221-235.

[2] On the trap and sandstone in the gorge of the Farmington river, at Tariffville, Conn. In Am. Jour. Sci., 3d ser., vol. XXXII, 1886, pp. 430-433.

In a review of Davis's conclusions, Dana[1] refers to the uniformity in the character of the Connecticut valley as indicating a common mode of formation. The vesicular texture of the upper surfaces of some of the trap sheets is referred to an escape of vapor, but is not considered as necessarily showing that the lavas were extruded at the surface.

In a recent paper on some of the trap ridges of southeastern Connecticut, by Hovey,[2] the conclusion is reached that all of the trap rocks in that portion of the state—considered by Davis as extrusive—are intrusive.

TRAP ROCKS OF THE NEW YORK-VIRGINIA AREA.

In the central and northern part of this area, as in the Connecticut valley, trap rocks are abundant, and appear principally as sheets, conformable more or less thoroughly with the bedding of the associated stratified rocks. In the southern part of the area, in Maryland and Virginia, trap sheets are much less abundant than farther north, but dikes increase in number. This change accompanies a decrease toward the south in the thickness of the system as it now remains, and favors the conclusion, that when the Newark rocks are deeply eroded, trap sheets disappear and trap dikes take their place.

In New Jersey the outcropping edges of the trap sheets form bold ridges, trending in a general way, north and south and facing eastward. Their westerly slopes conform to the dip of the associated shales and sandstones, and are inclined westward at angles of about 15 degrees.

The studies of Davis, and later of Darton,[3] have shown that the trap sheets of New Jersey are of two classes, intrusive and extrusive. The intrusive sheets comprise the Palisade, and what is probably its southern extension, known as Ten Mile run, Rocky hill, Pennington mountain, etc., a few miles north of Trenton, and other associated ridges in the same region.[4] The sheets forming the Watchung mountains are extrusive and are high up in the stratified beds unless a fault along the base of the most easterly of these ridges, believed to exist by Darton, can be proved. If such a fault does exist, and the basal conglomerate appears at the surface east of Paterson, it is probable that the extrusion of these rocks took place early in the history of the system.

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[1] Am. Jour. Sci., 3d ser., vol. XXV, pp. 474–475. The origin of the trap rocks near New Haven, Conn., has been critically discussed by J. D. Dana, since this paper was written on some of the features of nonvolcanic igneous ejections, or illustrated in the four "rocks" of the New Haven region, West Rock, Pine Rock, Mill Rock, and East Rock in Am. Jour. Sci., 3d ser., vol. XLII. 1891, pp. 79–110, pl. 2–7, and "on Percival's map of the Jura-Trias trap belts of central Connecticut, with observations on the upturning, or mountain-making disturbance of the formation," in Am. Jour. Sci., 3d ser., vol. XLII, 1891, pp. 439–447, Pl. 16. Proofs that the Holyoke and Deerfield trap sheets which are contemporaneous flows has been given Ben. K. Emerson in Am. Jour. Sci., 3d ser., vol. XLIII, 1892, pp. 146–148.

[2] Am. Jour. Sci., 3d ser., vol. XXXVIII pp. 361–383, and map.

[3] U. S. Geol. Sur. Bull. 67.

[4] As stated by Darton, Am. Jour. Sci., 3d ser., vol. XXXVIII, 1889, p. 136, the intrusive sheets of New Jersey comprise those forming the Palisades, Sour Land mountain, Cushetunk mountain, Round mountain, and the series including Lawrence brook and Ten Mile Run mountain, Rocky hill, Pennington mountain, Bald Pate, and Jericho hill, and the outcrops at Point Pleasant, Snake hill, Arlington, Martin's Dock, Neshanic, Bell mountain, Granton, and Brookville.

The extrusive sheets include all the outcrops constituting First, Second, and Third Watchung mountain and the ridges to the westward and the outlying outcrop near New Germantown.

The intruded sheets, although mostly near the eastern border of the area and near the base of the sedimentary series, are not all so situated. The trap of Cushetunk mountain is at the extreme western border and, in part, in contact with the bordering Paleozoic rocks. The generalization suggested by Davis, to the effect that the intruded sheets of the Newark system are all low down in the series, while the extruded sheets occur at higher levels, apparently can not now be applied in New Jersey; but when the structure of the New York-Virginia area is more thoroughly known, the hypothesis referred to may find support there as well as in the Connecticut valley.

Of the intruded sheets the most interesting is the one forming the Palisades. It is about 400 feet thick in Jersey City, and, as shown by Darton, rises northward by breaking across the bedding of the stratified rocks until, at the Hook mountains, in New York, its base is nearly a thousand feet higher than in Jersey City, and its thickness 850 feet. When followed westward to the extreme western end of the Hook mountain, it appears that the intruded rock reached the surface and overflowed.

Detailed observation regarding the nature and distribution of the trap rocks of New Jersey is given in the reports of the Geological Survey of New Jersey by Darton, in his article on the great lava flows and intruded trap sheets of the Newark system, and in Bulletin 67 of the U. S. Geological Survey, already referred to, and by Davis, in his paper on the relation of the Triassic traps and sandstones of the eastern United States.

The conclusion reached by Davis and Darton as to the extrusive origin of the traps of the Watchung mountains has not been accepted by the geologists of the New Jersey Survey, who urge that all of the trap sheets of New Jersey are intrusive.[1]

In that portion of the New York-Virginia area which crosses Pennsylvania, trap rocks are abundant and appear both as sheets and dikes, but little information is at hand to determine the nature of the sheets, though they are spoken of by the geologists of the Pennsylvania Survey as extrusive. The dikes are known to be numerous, and, as already stated, branch far out into the surrounding crystalline and Paleozoic rocks. In Maryland trap sheets are absent, but dikes occur which have been traced for many miles, principally in crystalline rocks. South of the Potomac several dikes have been observed, and intruded trap sheets are also present, as has recently been observed by Arthur Keith, but sufficient observation in this region has not been made to enable one to determine the distribution of their outcrop.

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[1] N. J. Geol. Surv., Ann. Rep. for 1888, pp. 16–44; ibid., 1889, pp. 66–72. Frank L. Nason, On the Intrusive Origin of the Watchung traps of New Jersey, in Geol. Soc. Am. Bull., vol. 1, pp. 562–563.

TRAP ROCKS OF THE NEWARK AREAS SOUTH OF THE NEW YORK-VIRGINIA AREA.

Throughout the numerous areas of Virginia and North Carolina, south of the New York-Virginia area, trap dikes are abundant, but no trap sheets have been observed. Some of the trap rocks in the Richmond area appear to be interstratified with the coal-bearing beds, but sufficient observation has not been made to prove whether these are truly interbedded sheets or simply dikes breaking obliquely across the strata. Dikes in the southern areas are most abundant in the easterly, but are not entirely wanting in the westerly belt of Newark areas. The dikes observed are in general parallel with the strike of the rocks, and are approximately vertical. In width they vary from a few inches to 50 or 75 feet, and have produced alterations in the texture and color of the adjacent rocks for a few feet along the lines of contact. In many instances the dikes may be followed for several miles across the country, their courses being marked usually by black, weather-beaten bowlders, but in no instance have they been mapped, and their number and distribution are unknown. They are indistinguishable in general appearance and in lithological and chemical characteristics from the trap rocks forming the great sheets of New Jersey and the Connecticut valley, or from the dikes traversing the adjacent crystalline areas.

SUMMARY RESPECTING THE DISTRIBUTION AND AGE OF THE TRAP ROCKS.

That the trap rocks traversing the Newark system in dikes and sheets belong to the great series of dikes intersecting the Atlantic coast plain from Nova Scotia to central Georgia seems sufficiently well established. The trap series at the south, in common with the sedimentary rocks they traverse, pass beneath Cretaceous and Tertiary beds, and therefore their full extent in that direction is unknown. The eastern border of the belt they occupy is also concealed in part beneath the ocean and, in part, by Cretaceous and more recent deposits. On the west the series reaches out in long dikes across the folds of the Appalachian.

In the crystalline and Paleozoic areas deep erosion has occurred, and only dikes now remain. The overflows of lava which probably once existed have been entirely eroded away. In some portions of the Newark areas, however, where the trap rocks, in common with the sedimentary beds, have been depressed below the base-level of erosion, trap sheets of great thickness still remain, and in other portions, where erosion has spared but little of the Newark series, trap sheets are absent, but trap dikes are common.

There is a direct association of trap dikes with the faults of the Newark system, as is illustrated by the contacts in the great fault crossing Bucks county, Pennsylvania, and in the Wadesboro area, where the strata adjacent to the narrow dikes show diverse dips. From this coincidence and the fact that both dikes and faults are a result of fracturing of the earth's crust and are hence due to the action of similar forces, it seems safe to conclude that both the dikes and faults are closely related and were probably, in part at least, contemporaneous. There are good reasons for believing that faulting was common at the time the Newark beds were being deposited, as is indicated by the great thickness of the conglomerates along the borders of the areas toward which the strata dip, but the widely extended faulting which imparts the characteristic structure of the Newark system took place after the beds were deposited and before or during the period of erosion which preceded the deposition of the next succeeding series of stratified beds. It was in this interval, also, that the intruded trap sheets and dikes were injected into the stratified series. This is shown by the fact that the next succeeding Potomac formation rests on the upturned and eroded edges of the Newark strata and on the truncated edges of the trap dikes which traverse them. The trap dikes in the crystalline and Paleozoic areas surrounding the Newark system do not assist in determining the age of the intruded rocks, for the reason that these terranes are all older than the Newark.

CHAPTER VIII.

DEFORMATION.

INTRODUCTION.

Throughout the Newark system the structure is monoclinal over broad areas. In general the strata are inclined at angles varying from ten to twenty degrees, but higher dips are of frequent occurrence. There is an absence of folds such as characterize the adjacent Appalachian system, and the strata have not been crumpled, except locally along fault lines. Displacements trending in general in a north and south direction have been shown to exist in very many instances, and are the controlling structural elements of the system. There are also a few great faults which trend at right angles to the prevailing strike of the rocks.

The prevailing monoclinal structure was one of the first features to be observed when the study of the system began, and many explanations of its origin have been suggested. It has been explained by H. D. Rogers[1] as being the position in which the strata were originally deposited. A similar suggestion was made by J. D. Whitney, after studying the structure of portions of the Connecticut valley area. The explanation advanced by H. D. Rogers was accepted by W. B. Rogers,[2] W. W. Mather,[3] and others, in the early days of American geology. More recent investigations have shown that none of the various Newark areas have a uniform structure throughout, and besides, the varied composition of the rocks and their great thickness, as shown by direct vertical measurements, so completely exclude all hypotheses of oblique deposition that their discussion is unnecessary.

Neither is it desirable, in the present state of geologic knowledge, to discuss the various suggestions that have been made with reference to the existing Newark areas being basal remains of great anticlinal ridges, or that they owe their monoclinal structure to the tilting of segments of the earth's crust many miles in width, without the formation of secondary faults.

These and other provisional hypotheses have been reviewed by Davis,[4] and their failure to explain the facts observed fully demonstrated. As the study of the Newark system has advanced and become more detailed, a large number of observations have been recorded, which show that the various fragments of the system now remaining owe their preservation to the fact that they are below the horizon of present base-level erosion, and occupy that position in large part by reason of depression, or the elevation of contiguous area through faulting.

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[1] Description of the geology of New Jersey. Philadelphia, 1840, pp. 166-171.

[2] Report of Progress, Geological Survey of Virginia, for 1839.

[3] Geology of New York, Albany, 1841, pp. 289-293.

[4] On the relations of the Triassic traps and sandstones of the Eastern United States; in Mus. Comp. Zoology, Harvard College, Bull., vol. VII, 1883, pp. 302-304.

Each area is characterized by the presence of faults of all degrees of displacement up to many hundreds of feet, which have repeated the outcrops of individual strata. In many instances the fault blocks have been tilted in the same direction, so as to be easily mistaken for a continuous monoclinal dip. Closer study in certain instances, however, has shown that each of these supposed monoclinal areas is broken into many independent blocks.

The study of the structure of the system consists in determining what deformations have resulted from the faulting and tilting of horizontally stratified beds resting unconformably on much older rocks, which are generally metamorphosed and highly inclined. This being the direction in which recent investigation leads, let us see what evidence should be required to demonstrate that it is in reality the structure of the system under review.

It has been clearly shown by Davis, in discussing the structure of the Connecticut area, that the larger faults found in that region must affect the underlying crystalline rocks. My own studies have shown that the same conclusion may be extended to other areas of the system. Should the plane of erosion be depressed sufficiently, it is evident that at horizons near the base of the Newark system, the upheaved edges of fault blocks composed of crystalline rocks should appear at the surface as narrow belts intersecting the sedimentary beds. Owing to the greater resistance usually offered by the crystalline rocks to erosion, such protrusions would appear as ridges, standing in relief and dividing the superimposed beds. Bordering such ridges and resting on the crystalline rocks, one should find outcrops of the basal conglomerate of the Newark system, succeeded by sandstones and shales. On margins of the Newark areas where the line of junction with the surrounding crystalline rocks crosses the strike of the sedimentary beds, there should be long, narrow, finger-like extensions of crystalline rock, entering and dividing the sedimentary beds.

Another result of the deep erosion of faulted sedimentary beds resting on crystalline rocks would be the occurrence of narrow strips of sedimentary beds occupying the depressed borders of fault blocks and separated from larger areas by a ridge of the lower formation.

In the study of the various Newark areas peculiarities in outline and in topographic form which should be expected to result from the faulting and erosion of horizontally stratified beds resting on more resistant crystalline rocks as stated above have been found abundantly developed.

In the present chapter the available evidence in reference to the structure of the various Newark areas will be briefly summarized and the conclusion to which it points indicated. After ascertaining what the structure of the system is, the attempts that have been made to explain its origin will be considered.

STRUCTURE OF THE ACADIAN AREA.

For our knowledge of the structure of the Newark rocks of Nova Scotia we are indebted almost entirely to the writings of Dawson.[1] The general dip of the rocks along the eastern border of the bay of Fundy is northwest at an angle of about 15 degrees. On the New Brunswick shore there are several isolated areas belonging to the same system which dip northeastward at angles varying from 25 to 35 degrees. These inclinations have led to the conclusion that the Acadian area has a synclinal structure. That such is the case, however, can not be accepted as a final conclusion, for the reason that a faulting and tilting of the strata would account equally well for the observed dips. In the eastern part of the Acadian area, about the Minas Basin and Cobequid bay, the strata are much disturbed and dip toward all points of the compass, and at all angles from near horizontality up to 50 degrees or more. Some faults have been recognized in this region, but a characteristic fault structure, although indicated, has not been demonstrated. The structure is, however, certainly distinct from the great synclinal suggested by the opposite dips on the east and west shores of the bay of Fundy, and so far as recorded observations indicate falls in line with the prevailing fault structure characteristic of the more southern areas of the same system.

The presence of two ridges of trap at Digby neck, in the southern portion of the Newark area bordering the bay of Fundy on the east, can apparently be explained by a fault, as can also the presence of parallel submerged ridges in the adjacent portion of the bay of Fundy. Further field study is necessary, however, before the structure of this area can be considered as definitely determined; but the recorded evidence, supplemented by observations made during a brief reconnaissance by the present writer, certainly favors the hypothesis that the attitude of the Newark system in Nova Scotia has resulted from the tilting of faulted blocks.

STRUCTURE OF THE CONNECTICUT VALLEY AREA.

This area has been more thoroughly studied than any other in the series, and its general structure is known, although much detail work undoubtedly remains to be done. Our knowledge of its structure and of the nature of the trap sheets that traverse it has been greatly advanced during the last few years by the investigations of Davis.[1] In the southern portion of the area concerning which the most recent reports have been made the strata are broken by numerous faults, trending in general north and south with the strike of the rocks. The fault blocks, with some exceptions, are tilted eastward at varying angles up to 15 degrees. Other faults trend obliquely to the strike of the rocks in such a way at to throw the outcrops of hard beds out of line. There is good evidence for believing that in many portions of the eastern border of the area there are marginal faults which cause the eastward-dipping strata to abut against the adjacent crystalline rocks. The marginal faults belong to the same system as the strike faults in the central portion of the area, but deserve separate mention on account of their great importance in indicating the former extent of the stratified beds now claiming our attention.

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[1] Acadian Geology, 3d ed., London, 1878; pp. 86–127 and map. Supplement, pp. 28–30.

The structure along the east margin of the Connecticut valley area, as illustrated by Davis, is shown in Fig. 1, in which a portion of the marginal fault mentioned above is indicated. The throw of this fault must be several thousand feet.

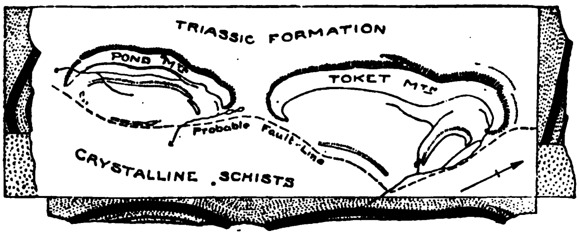

FIG. 1.—Fault on east side of Connecticut valley area, after W. M. Davis.

The determination of the structure of the Connecticut valley area has been rendered possible by the discovery of Davis that some of the trap sheets traversing it were extruded at the surface during the deposition of the Newark sediments and were buried by later deposits. In the deformation and erosion of the area they play the rôle of hard, sedimentary beds, and enable one to determine the structure in a manner more satisfactory than seems possible in other portions of the same system where sandstones and shales alone occur. Since these pages were written the structure of the Connecticut valley area has been still further discussed by Dana.[2]

STRUCTURE OF THE SOUTHBURY AREA.

This area may be considered as an outlier of the Connecticut valley area from which it is separated by about 16 miles of crystalline rocks.

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[1] On the relations of the Triassic traps and sandstones of the Eastern United States; in Mus. Comp. Zoology, Harv. Coll. Bull., vol. VII, 1883, pp. 249-309, Pl. 9-11. Also "Triassic formation of the Connecticut Valley," U. S. Geol. Survey, Seventh Ann. Rep., 1885-'86, Washington, 1888, pp. 455-490, Pl. 52, and the lost volcanoes of Connecticut, Pop. Sci. Mo., vol. XL, 1891, pp. 221-235.

[2] "On Percival's map of the Jura-Trias trap belts of Central Connecticut, with observations on the upturning or mountain-making disturbance of the formation," in Am. Jour. Sci., 3d ser., vol. XLII, 1891, pp. 439-447, Pl. 16.

It is so far removed from the Connecticut valley area that its former connection is not usually admitted; but the fact that similar areas in detached fault basins are common in connection with the main areas in Virginia and North Carolina suggests that the Southbury area also occupies a local fault basin, and that its preservation is due to the depression by faulting of a small portion of the original Newark terrane below the present horizon of base-level erosion.

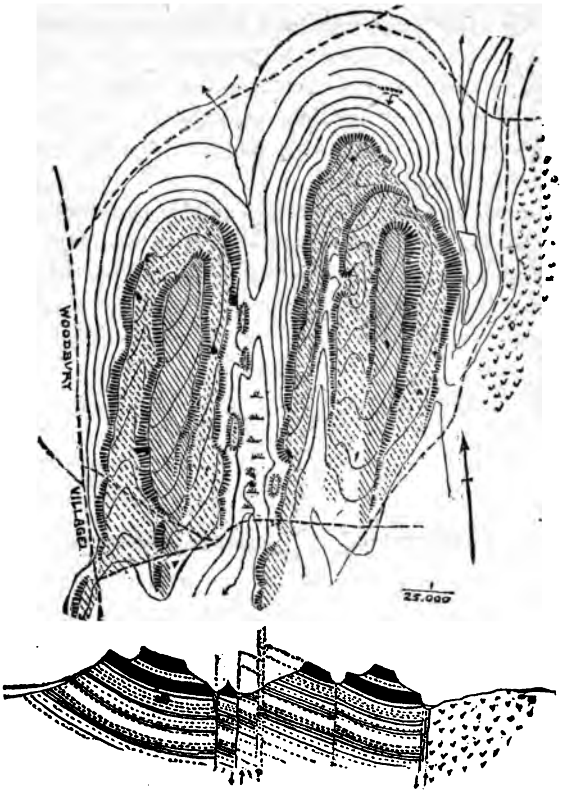

FIG. 2.—Map and section of Southbury area, after W. M. Davis.

This area has been studied by Davis,[1] and its structure illustrated by the accompanying map and section (Fig. 2). The rocks comprise several hundred feet of sandstone and conglomerates at the base; next, a thin, amygdaloidal trap; then 200 feet or more of shale and calcareous beds; then a heavy sheet of trap. Other superior members exist, but are mostly concealed by drift. The attitude of these beds is so well shown in the accompanying figure that further description may be dispensed with.

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[1] U. S. Geol. Survey, Seventh Ann. Rept. for 1885-'86. Washington, 1888, p. 468.

STRUCTURE OF THE NEW YORK-VIRGINIA AREA.

Although a large amount of time has been devoted to the study of this area, its structure has not been satisfactorily determined.

In New York and New Jersey the general dip of the strata is toward the northwest, but many exceptions have been recorded. As shown by Darton and Nason, the observations of dip indicate that the strata are broken into blocks which have a monoclinal structure. Only a few faults have been distinctly traced, however, and these are usually small. A great fault, having a throw of perhaps 2,000 feet, is supposed by Darton[1] to exist on the east side of the Watchung mountains, in the neighborhood of Paterson, which brings to the surface the characteristic basal conglomerate of the system.

There are several reasons for believing that the western border of the area, from near Morristown, New Jersey, northward to the Hudson, is determined by a displacement. Along this junction the Newark rocks dip uniformly westward to within a short distance of the line of contact, but the actual junction has not been seen, owing to the thickness of the superficial drift. The conditions are here apparently the same as along portions of the eastern margin of the Connecticut valley area, and at the junction of some of the Newark areas in Virginia and North Carolina with bordering crystalline rocks where marginal faults are known to exist.

The line of bluffs of crystalline rock overlooking the Newark area from Morristown to the Hudson continues eastward and forms a bold line of hills, when seen from the south, through Westchester county, New York, and into Connecticut. The presence of a fault along the base of these hills, I have been informed by Darton, is indicated by an abrupt change in the character of the rocks. This region has been studied by Smock,[2] who describes an abrupt change in the lithology, but does not explain its origin.

Perhaps I go too far in making the above suggestion; but there are several indications which lead to it as a working hypothesis which future students of the region would do well to bear in mind. The line of bluffs referred to northward of Morristown marks the shore line during certain stages of the deposition of the Newark rocks, which was possibly determined by a line of faulting that was in process, and increased its displacement from time to time during the deposition of the Newark beds.

The most important fault observed in the New York-Virginia area occurs in Bucks county, Pennsylvania, and in adjacent portions of New Jersey. The course of this fault is known for about 40 miles and probably has a greater length. Its general direction is north and south, but it is strongly curved, being concave toward the northwest. From near Lambertville, where it crosses the Delaware, for about 6 miles northwestward, it has brought to the surface a narrow outcrop of Silurian rocks on which rest the basal conglomerate of the Newark system. On the east side of the Delaware, in New Jersey, an outcrop of trap occurs in the midst of the fault rock which marks the course of the displacement, suggesting that the fracture was sufficiently deep to reach molten material. In general, on the north side of the fault the strata are inclined toward the northwest, while on the south they dip northeast. The rocks immediately adjacent to the displacement have been greatly fractured and slickensided, and in places where the exposures are obscure this fault rock enables one to trace the line of fracture with tolerable certainty. The strip of Silurian rocks brought up by this fault is represented on the large maps accompanying the reports of the First Geological Survey of Pennsylvania; but the structure of the region does not seem to have attracted special attention during the progress of the survey. Its position is shown on the accompanying map, forming Pl. IV. The facts here stated are principally from an account published by Lewis.[1] Secondary faults, at right angles to the prevailing strike of the Newark rocks of Pennsylvania are reported by Lewis, but these are of small importance in a study of the general structure.

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[1] Bull. U. S. Geological Survey, No. 67, p. 18.

[2] A Geological Reconnaissance in the Crystalline Rock Region of Dutchess, Putnam, and Westchester counties, New York. 39th Ann. Rept. of the Trustees of the New York State Museum of Natural History, Albany, 1886, pp. 165–185.

In a section across the eastern rocks of southeastern Pennsylvania, from near Dillsburg, S. 47° 31′ E., to Beelers Cross Road, by Frazer,[2] a uniform southwesterly dip is given, ranging from 16 to over 40 degrees, excepting near the west end of the section, where a broad, gentle syncline is introduced. The dips and rock structure recorded in describing this section might apparently be equally well explained by the introduction of faults. Unless the exposures are as complete as represented by Frazer, it does not seem safe to assume such a great thickness as his section indicates, or to introduce a synclinal structure, which is exceptional for these rocks. A portion of the western border at Cornwall iron mine, near Dillsburg, has been shown by J. P. Lesley and E. V. d'Invilliers[3] to be determined by a great displacement, which brings the westward dipping strata of the Newark system in abrupt contact with Paleozoic strata.

The most recent studies of the Newark system in Pennsylvania have, in general, not indicated the presence of a faulted monoclinal structure. The absence of easily recognizable strata, as in many other parts of the system, unfortunately renders it difficult to determine the structure of the region. Many observations of dip and other phenomena have been recorded by the Second Geological Survey, but no digest or systematic study of these observations has been made. Until this is done by one familiar with the region it is impracticable to draw any general conclusion from the many observations recorded.

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[1] A great trap dike across southeastern Pennsylvania. In Am. Phil. Soc. Proc., vol. XXII, 1885, pp. 438–456. Map op. p. 40.

[2] Second Geol. Surv. of Pennsylvania, Report of Progress in the counties of York, Adams, Cumberland, and Franklin. Vol. C 2, 1875. Harrisburg, 1887, pp. 265–270. Pl. op. p., 264.

[3] Second Geol. Surv. of Pennsylvania. Ann. Rep. for 1885, pp. 496, 498, 506.

The eastern border of the Newark system in Pennsylvania, Maryland, and Virginia is irregular, owing apparently to inequalities in the floor on which the stratified beds were deposited, or possibly to subsequent disturbances. These inequalities have been exposed at the surface by erosion, and indicate that along this border the Newark beds have but little thickness. In some places they have been cut through by stream erosion so as to expose the crystalline rocks beneath.

The structure of the southern portion of the New York-Virginia area has not been determined. The inclination of the beds south of the Potomac is in general northwestward, and to a casual observer the strata appear to have a continuous monoclinal dip from side to side. The rocks, however, are mainly shales and shaly sandstones, and the presence of faults would be difficult to determine.

At Brooklyn, a few miles west of Centerville, Virginia, there is a series of parallel ridges trending nearly north and south, which present sharp escarpments to the eastward. These ridges owe their prominence to the outcropping edge of a trap sheet which has been broken by faults. The trap sheets in each fault block have a dip of about 25° to the northwest, corresponding with the inclination of the associated shales and sandstones. The presence of trap sheets in this region, it is to be hoped, will assist in the future study of its structure in the same manner that similar sheets in the Connecticut valley have led to the determination of the deformations that there occurred.

STRUCTURE OF THE BARBOURSVILLE, STOCKVILLE, DANVILLE, AND DAN RIVER AREAS.

These areas fall in line with the southern extension of the New York-Virginia area, and have the same general structure. The strata of which they are composed dip westward, and in many places abut against the bordering crystalline rocks. The presence of marginal faults has not been determined by direct observation, but the persistent westward dip of the Newark strata, close to the line of junction, can not be explained unless such faults are postulated. In the Dan river area especially, the high dip of the Newark system, amounting in many instances to fully 50 degrees within a few rods of the line of junction with the crystalline rocks, is a very strong indication of marginal faulting. The western border of each of the areas here considered is composed of coarse conglomerate, derived from the crystalline rocks toward which the strata are inclined. In general the conditions are the same as along the northwestern border of the New York-Virginia area and the eastern border of the Connecticut valley area.

In the Barboursville area the structure is obscure and greatly disturbed. The presence of coarse conglomerates along both its western and eastern margins indicates that the strata have not great thickness.

The dips observed at several places are uniformly westward, at angles of about 20 degrees. No faults or folds have been discovered, but may exist, as the exposures are not good. The area is bordered on all sides by old hills, and forms a topographic basin which owes its origin to the greater ease with which the stratified rocks yield to erosion.

In the Scottsville area the dip is westward throughout, at angles varying from 15 to 20°. No structural features excepting the dip of the strata have been observed.

The Danville and Dan river areas are remarkable for the high inclination of the strata composing them. In many places, throughout continuous sections over a mile in length, the beds have a persistent westward dip at angles varying from 35 to over 50°. The White Oak mountains forming the most conspicuous portion of the Danville area are composed of sandstones and shales, and stand in relief and form an exception to the statement made on a preceding page to the effect that the Newark areas at the south are usually lower than the crystalline areas bordering them. The trend of the range is a little east of north, but does not coincide with the strike of the strata composing it, which is nearly northeast and southwest.

The Danville area terminates abruptly at the south, and appears to have been separated from the Dan river area by a profound displacement trending northwest and southeast, or at right angles to the prevailing strike of the rocks. The abrupt manner in which the strata at the northeast extremity of the Danville area abut against the crystalline rocks, when followed northwestward along the strike, is well shown near the little hamlet of Cascade. The junction of the two formations is a straight line at right angles to the strike of the Newark beds. Along the line of junction the Newark strata dip northwest at angles varying from 30 to 35°.

This locality has not been thoroughly studied, but from the reconnaissance made it seems as if the Newark strata had been depressed into the crystalline rocks along the junction of two faults which meet each other at nearly right angles. In a newly constructed mill race, situated between Cascade and the neighboring railroad station, the following detailed section was measured: The section is 1,370 feet long as measured at the surface, and runs at right angles to the strike of the rocks. The dip throughout is northwest 30 to 33°. The rocks were well exposed, and show no indications of faults or folds, excepting that the hard sandstone strata are very similar in composition, and are repeated with surprising regularity in certain portions. Only a few rods northeast of this section, i. e., in the direction of strike, the stratified beds end abruptly, and are replaced by crystalline rocks. The measurements given below show vertical thickness; the first or highest member in the series is at the west, where the dam from which the race starts is situated.

Vertical section, near Cascade, North Carolina.

	Feet.
Compact black slate, becoming sandy in weathered outcrops	33·0
Compact gray sandstone	2·5
Black shale, poorly exposed	122·0
Hard, gray sandstone	2·0
Thin-bedded sandy shale, passing into sandstone below	19·0
Compact gray sandstone	2·5
Sandy shale	3·0
Compact gray sandstone	2·0
Shale, light-colored, even-bedded	19·0
Hard sandstone, with partings of shale	3·5
Shale, yellowish, sandy	19·0
Sandstone, hard, bluish, resembling gneiss	3·5
Shale, yellowish	12·0
Sandstone, compact, somewhat broken	2·5
Shale	8·0
Sandstone, compact	3·0
Shale	12·0
Sandstone	2·0
Shale	6·0
Sandstone	2·0
Shale, broken, exposures obscure	8·0
Sandstone, hard, bluish, resembling gneiss	6·0
Shale	19·0
Sandstone, hard, bluish, resembling gneiss	6·0
Sandstone, compact	5·0
Sandstone, shaly	5·0
Shale, black	1·0
Sandstone, shaly	2·0
Sandstone, shaly, irregular, disturbed	3·5
Shale, black	1·0
Sandstone, compact, even-bedded	2·0
Sandstone and shale, in thin layers	4·0
Slate, black	2·0
Sandstone, compact	3·0
Shale or slate, black	5·0
Sandstone, in thin layers with shaly partings, even-bedded	15·0
Shale, yellowish, micaceous, black at bottom	3·5
Sandstone, compact, bluish	5·5
Slate, black, shaly	3·5
Sandstone, with shaly partings, passing below into slate	13·0
Shale, black	4·0
Sandstone, compact, bluish	2·0
Shale, black, yellowish on weathering	7·0
Sandstone and shale, in thin layers	9·5
Sandstone, shaly	5·0
Sandstone, compact, bluish	10·0
Shale, yellowish	20·0
Unexposed	100·0
Shale, sandy	22·0
Sandstone, compact, bluish	2·5
Total vertical thickness, about	473·5

Another section exhibiting the characteristics of the strata of the Dan river area occurs at Leekville, and resembles closely that given above excepting that on the west it passes into a heavy granitic conglomerate, which in limited exposures can not be distinguished from the undisturbed granitic terrane bordering the Newark area on the west.

The system throughout the Dan river area is characterized by the presence of heavy beds of black slate and of dark colored shales, resembling closely the medial portions of the Richmond and Deep river areas.

All through the Dan river area the rocks are inclined westward, and no faults of any considerable extent have been observed, although small ones in much disturbed sandstones and shales may be seen in cuts along the Cape Fear and Yadkin Valley railroad. A marginal fault, on the west side of the area near Leeksville, is suggested by the high westward inclination of the conglomerates close to their junction with the granitic rocks on the west. The Dan river area, as shown on Pl. I, is the most southern of the western belt of Newark areas, the northern terminus of which is on the Hudson. Throughout this entire series the general dip is westward, except in Pennsylvania, where the terrane curves to the west and the prevailing dip is northward. Throughout the entire belt, however, the dip is toward the ancient shore from which the debris forming the Newark beds was derived.

In Virginia and North Carolina there is another belt of Newark areas, to the eastward of the one here described, in which the prevailing dips are to the southeast. Between these two belts is the small Farmville area, in which the strata are greatly disturbed and dip sometimes to the westward and sometimes to the eastward.

STRUCTURE OF THE FARMVILLE AREA.

In crossing this area from east to west, one finds that the strata have diverse inclinations and change abruptly from northeast to northwest dips. During my reconnaissance of the area, in 1885, the presence of at least four north and south faults in the central portion of the area was determined. The area as a whole, however, is, topographically, a basin surrounded by hills of crystalline rocks, and exposures are too indefinite to admit of a ready determination of its structure. On its eastern border, about 2 miles north of Farmville, the presence of a heavy marginal fault is clearly shown in recent mining explorations. At this locality the Newark system is composed of fine, light colored sandstones and shales, with several much disturbed coal seams, and abuts against granite. The stratified rocks near the line of contact are much disturbed, broken, and slickensided. They are not shore deposits, no coarse conglomerates being present, but offshore and swamp accumulations. That their abrupt termination against the granite has resulted from displacement and is not due to original deposition is beyond question.

In the small detached area about 6 miles south of Farmville the rocks are principally shales, with some sandstone layers and occasional coal seams. Coarse conglomerates do not appear at the surface. The prevailing dip is northwest, 20 degrees. No folds exist, and the presence or absence of faults has not been determined.

STRUCTURE OF THE RICHMOND AREA.

PREVIOUS OBSERVATIONS.

In Lyell's well known essay on the Richmond coal field,[1] and in other writings by the same author, the rocks of this area are considered to have been deposited in a local basin of about the same extent as the present coal field, and to have a synclinal structure. These conclusions have been repeated by nearly all subsequent writers on the subject with the exception of W. M. Fontaine, whose work will be noticed later, and F. H. Newell,[2] who has shown that the coal seams were not accumulated in the restricted basin, and do not thin out at the outcrops, as previously considered, but are faulted and crushed.

The occurrence of a double line of coal outcrops along the eastern margin of this area was recognized by Rogers,[3] during his survey of Virginia, and considered to be a result of faulting. He believed, however, that the Newark strata in the Richmond area and elsewhere were deposited in an inclined position, as had been explained by H. D. Rogers, and did not determine its structure or advance any definite ideas concerning the deformations that had taken place.

The presence of faults on the eastern border of the area is indicated in a section published by Taylor[4] in 1835, unaccompanied by any discussion.

This area has been studied by Fontaine,[5] in connection with other areas of the same system. His conclusions respecting its structure are stated as follows:

> My examination of some of the finger-like remnants of the Mesozoic, now found at the northern end of this field, thrust out in the Azoic, put me in possession of what I think is the explanation of the peculiarities of the structure of this field, and of the interior belts. The history of these areas, briefly stated, seems to be as follows:
>
> The strata were laid down in depressions, which, originally shallow, were subsequently deepened by a more or less rapid subsidence. The subsidence was due, as previously stated, to the operation of a lateral thrust. It continued until faults and overturned anticlinals were produced. In the interior belts (the New York-Virginia, Barboursville, Scottsville, Danville, and Dan river areas) these operated to produce a constant northwest dip. This resulted from the fact that the western sides of the severed earth prisms dropped, producing, sometimes, by a roll of the prisms, an upthrow of the eastern side. This appears to occur in some of the faults of the Richmond coal field also. When the strain did not result in producing rupture and

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[1] Geol. Soc. London, Quart. Jour., vol. III, 1847, pp. 261-280, Pls. 8, 9.

[2] The Richmond Coal Field, Virginia. Geol. Mag., London, Dec. 3, vol. VI, 1889, pp. 138-140.

[3] Reports on the Geology of Virginia for 1835, p. 55, and for 1840

[4] Pennsylvania Geol. Soc., Trans., vol. I, pp. 275-294, Pls. 16, 17.

[5] Notes on the Mesozoic of Virginia. Am. Jour. Sci., 3d series, vol. XVII, 1879, pp. 36-37.

> faulting, it caused the development of an anticlinal, affecting but a narrow belt, which was overturned to the eastward, thus producing also a continuous northwest dip. Where the strata have suffered enormously from erosion, and where almost precisely similar beds are formed by the similar conditions of deposition found repeated at different horizons, as is often the case in the interior belts, it is almost impossible to detect reduplications by faulting and folding. When the period of faulting was reached eruptions of trap took place. It will thus be seen that the continuous dips would by no means give a true indication of the thickness of the series.
>
> In the Richmond coal field the faults and narrow overturned folds are not of sufficient magnitude to produce, as in the interior belts, continuous dips, but suffice only to render very variable and uncertain the dip and position of the strata toward the center of the field. The general result seems to have been to flatten the dip here and to steepen it on the western side. Some of the twists in the strata produced by the overturned anticlinals are of extremely limited extent. I have seen them only a few feet wide.
>
> The direction in which the lateral thrust operated in this field was from east to west, and it seems not yet to be exhausted, for this region is often affected by minor earthquakes, and at intervals of ten or fifteen years by very powerful ones; the last occurring a few years ago. The shocks pass from east to west. It is probable that the gradual depression of the coast is connected with this westward thrust.

A detailed account of the strata penetrated during mining operations near Midlothian has been given by Heinrich[1] and the structure indicated in the plates which accompany his paper.

PERSONAL OBSERVATIONS.

The observations of the present writer made in 1885 seem to warrant the conclusion that the Richmond area has been greatly disturbed by fracturing, especially along its eastern and western margins, and that as a whole it owes its preservation to faulting which carried the strata below the horizon of subsequent base-level erosion, or else elevated the contiguous areas. The faulting that has taken place along the margins of the area indicates that the strata were formerly more extended than now. Erosion has been great, and it is evident that what now remains of the Newark strata is but the remnant of their original extent.

Section along the James river.—The only natural section of any considerable extent in this area is along the left bank of the James from a point on the east nearly opposite the site of Bellona arsenal, westward to Dover, a distance of between 7 and 8 miles. At each end of this section the rocks are much disturbed and broken along north and south displacements. The general dip at each end is toward the center of the area, at angles varying from 15 to 70 degrees. In the central portion of the section, for a distance of about 4 miles, the strata form a broad, gentle synclinal, the central part of which is nearly horizontal, the dips on the eastern and western borders varying from 5 to 8 degrees. Near the west end of the section, at Boscobel, there is a mass of crystalline rocks included between highly inclined Newark strata. This is formed

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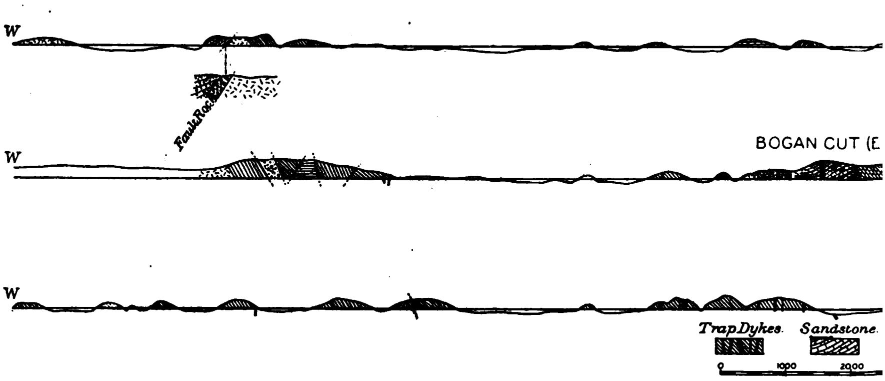
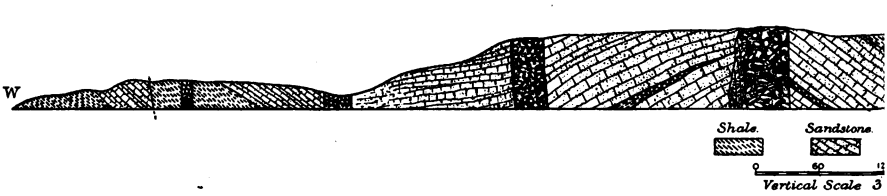
[1] Mesozoic formation in Virginia. In Am. Inst. Min. Eng., Trans., vol. VI, 1879, pp. 221-224, Pls. 1-2.



SECTION OF NEWARK ROCKS ALONG CAR



SECTION ON NORTH

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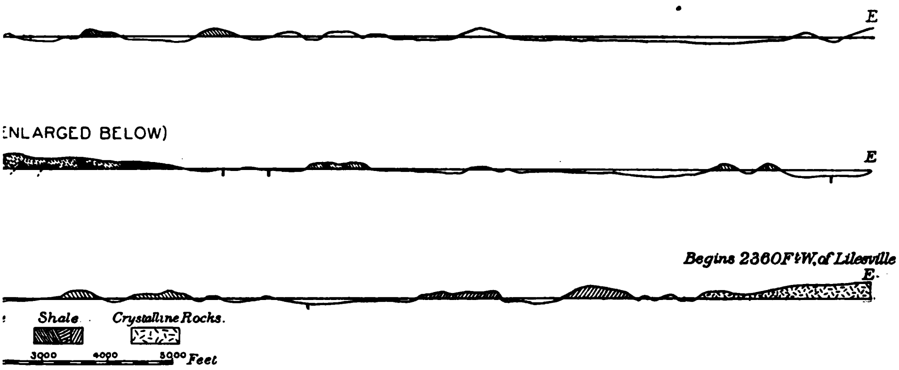
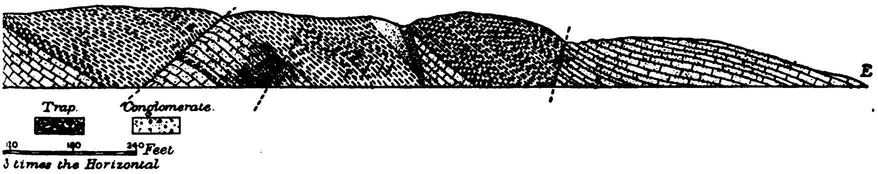


ROLINA R.R THROUGH WADESBOROUGH N.C.



SIDE OF BOGAN CUT.

TIONS.

by the tongue-like prolongation of crystalline rock which enters the Newark area from the north and extends across the James river as shown on the map forming Pl. V. The presence of this wedge of crystalline rock, disturbing the continuity of the sedimentary strata, is due to a fault which has brought up the floor on which the Newark rocks were deposited, together with the basal conglomerate which rests upon it. On the east side of the wedge near the Dover mines the Newark rocks are disturbed and faulted, and have a general southwest inclination at angles varying from 15 to 20 degrees. On the west side the stratified rocks are also much disturbed and faulted, and in general dip eastward.

West border of the area.—The Dover mines, on the north side of the James, and the Powhatan, Norwood, and Old Dominion mines, on the south side of the river, are ranged in line along the west border of the area, and may be considered as constituting a single district. In this district, as has been demonstrated by mining operations, the inclinations of the rocks change abruptly from northwest at some localities to southeast at others near at hand, the inclinations varying from 15 to 20 degrees. This diversity is explained by the fact that the district has been broken by approximately north and south faults, and that the included beds have been variously tilted. The structure is especially well illustrated in the Norwood mine, in which the coal in certain of the fault basins has been worked out and the forms of the troughs demonstrated. These mines are located on the low bluff bordering the flood plain of the James, and the coal comes to the surface, although the lines of outcrop are concealed by superficial clays and gravels. The coal is worked by means of "slopes" following the dip of the seams. In the workings which were open in 1885 the dip is westward at an angle of from 20 to 25 degrees. The main slope had been excavated, following the inclination of the strata, for about 300 feet, and exposed sections of two coal seams, both of which are irregular in thickness, owing to disturbances along small faults. Three principal faults were exposed at the time of my visit, all remarkably uniform in strike and hade, and in the direction in which the fault blocks had been tilted. The displacement amounted to 5 or 6 feet in each instance, and the fault planes are inclined eastward at angles of from 60 to 70 degrees with a horizontal plane. Each of the fault blocks is tilted at an angle of 20 to 30 degrees toward the northwest. At the bottom of the slope another fault of greater magnitude was encountered, the hade of which is westward at an angle of 20 to 30 degrees. Along each line of faulting the coal had been pinched out to a mere "stringer" of comminuted and slickensided fragments. The fracturing and crushing were so complete near the lines of disturbance that the fragments of coal and associated shale are intimately mingled, much to the detriment of the former. In many cases the slickensided fragments, measuring an inch or two in diameter, can be removed with the hand.

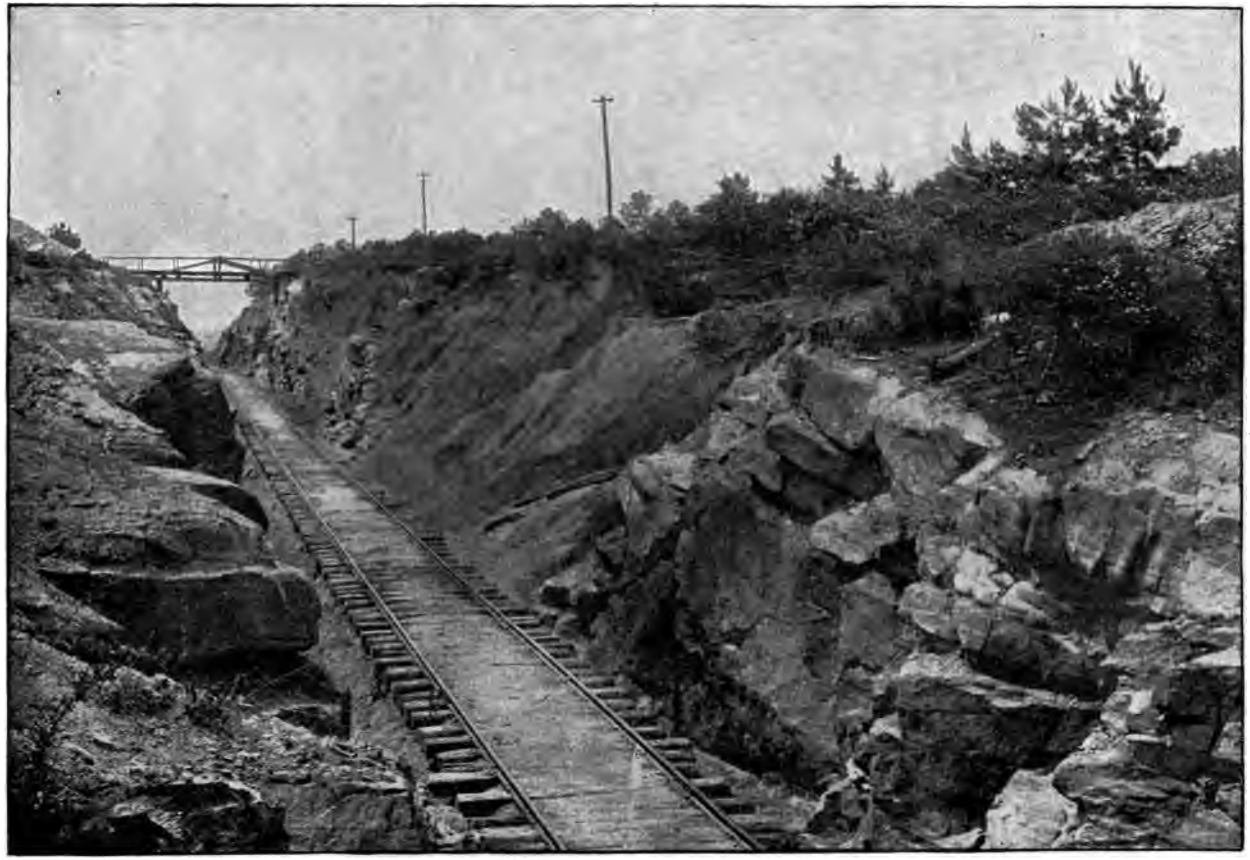
Owing to the drag of the strata on the thrown side of the faults, the dip of the beds seems to be in opposite directions from the lines of displacement, and decreases in inclination a few feet distant. This occurrence has led the miners of this district to apply the term "roll" to these disturbances. In some instances it was apparent that motion had taken place throughout a belt of comminuted and slickensided fragments or "fault rock," several feet broad, thus rendering it impossible to indicate a precise line of fracture.

These displacements are accompanied by a thinning of the coal adjacent to the planes of fracture and a thickening in the central portion of the fault blocks. This phenomenon has been observed in many other mines in the Richmond area and is probably the explanation of the great thickness reported in some of the coal seams along the eastern margin of the area and in detached basins adjacent thereto.

East border of the area.—In the neighborhood of Midlothian there is a double line of coal outcrops separated by a strip of crystalline rocks having a breadth of approximately 2,000 feet. The western line of outcrop marks approximately the boundary of the main coal field, while the eastern line is formed by coal seams in detached basins. Mining in this region has demonstrated that there are at least two separate basins in the outlying strip of coal-bearing rocks. These are the Black Heath and Green Hole areas, widely known during early mining operations in Virginia. Other small areas are indicated on some maps as falling in line with these, but whether they form separate basins or not is uncertain. So far as the dominating structure of the region is concerned, all of these small local areas may be considered as one.

In the eastern border of the main area at Midlothian the strata, although disturbed by many small faults, are inclined westward at an angle of between 15 and 20 degrees. In the outlying local basins the strata are reported to be inclined from each side toward the center, so that each stratum forms two parallel lines of outcrop. It is also reported that the coal seams are thin along their outcrops and thicker in the central part of the basins. The structure of these basins was not accurately recorded during the time that coal was being removed and it is now impracticable satisfactorily to renew their study. From such observations as I was able to make, aided by the writings of Lyell and the verbal reports of miners who helped to win the coal, I judge that the strata dip to the westward, but that the softer layers, including the coal, were dragged along the plane of faulting and thus simulate a sharply folded synclinal. The fault which cut off the basins follows their western border and hades eastward.

The small detached area in which the Deep river mines are situated, north of the James and about 3 miles east of the east border of the main area, is another illustration of the occurrence of a narrow strip of Newark rocks occupying a detached fault basin. The main fault to which this little area owes its depression, and consequent preservation, follows



BOGAN'S CUT, NORTH CAROLINA, LOOKING WEST.

its west border. The bluff of crystalline rocks overlooking it on the west is in reality the heaved side of the fault, the strike of which is about northeast and southwest and the hade eastward. In this area, as in the Green Hole and Black Heath basins, some of the soft strata appear to have parallel lines of outcrop. The line of supposed outcrop along the west side of the basin, however, is due to the drag of the coal and associated shales along the fault plane. As in similar basins south of the James, the coal is thin at the outcrops and thickens in the center of the fault blocks. As in the areas mentioned above, the structure simulates an abruptly folded synclinal, with strata thickening in the center. The coal in this area is much broken and slickensided, and secondary faults were encountered during mining operations. The roof of shale above the coal is in many places a mass of comminuted and slickensided fragments, which in some instances during mining operations flowed out from openings like so much gravel. Here, as elsewhere in the secondary areas and in the bordering outcrops of the Richmond coal field, the difficulties and uncertainties of mining were greatly enhanced by the faulting and crushing that the strata had suffered.

At Clover hill, in the southern part of the eastern border of the Richmond coal field, coal has been mined for a long series of years. In 1885, this was the only point at which active mining operations were being carried on. The "incline" which was being worked followed the slope of the coal seams for about 250 yards. The dip of the strata is northwest 20 to 35 degrees, and the strike S. 10° 30′ W., agreeing very nearly with similar measurements at Midlothian. At the date mentioned, mining operations were limited on the west by a fault, striking about north and south, the throw of which was undetermined but exceeds 50 feet. In the mines there are several minor faults, parallel to the one on the west, some of which have a displacement of 40 to 50 feet. The structure, although seemingly more regular than the Midlothian or Norwood, is essentially of the same character; that is, the rocks are faulted, but the strata in each fault block return with remarkable persistency to about the same dip.

A marginal fault along portions of the east border of the Richmond coal field, which brings the broken edges of the Newark strata in direct contact with the surrounding crystalline rock, has been determined. A cross fracture is indicated by a break and offset in the line of coal outcrops just east of Midlothian. The tongue of crystalline rock penetrating the main Richmond area at the extreme northern end, as shown on Pl. V, seems also to be due to a fault which has brought up the crystalline floor on which the Newark rocks rest. The actual presence of such a fault, however, has not been demonstrated by observation.

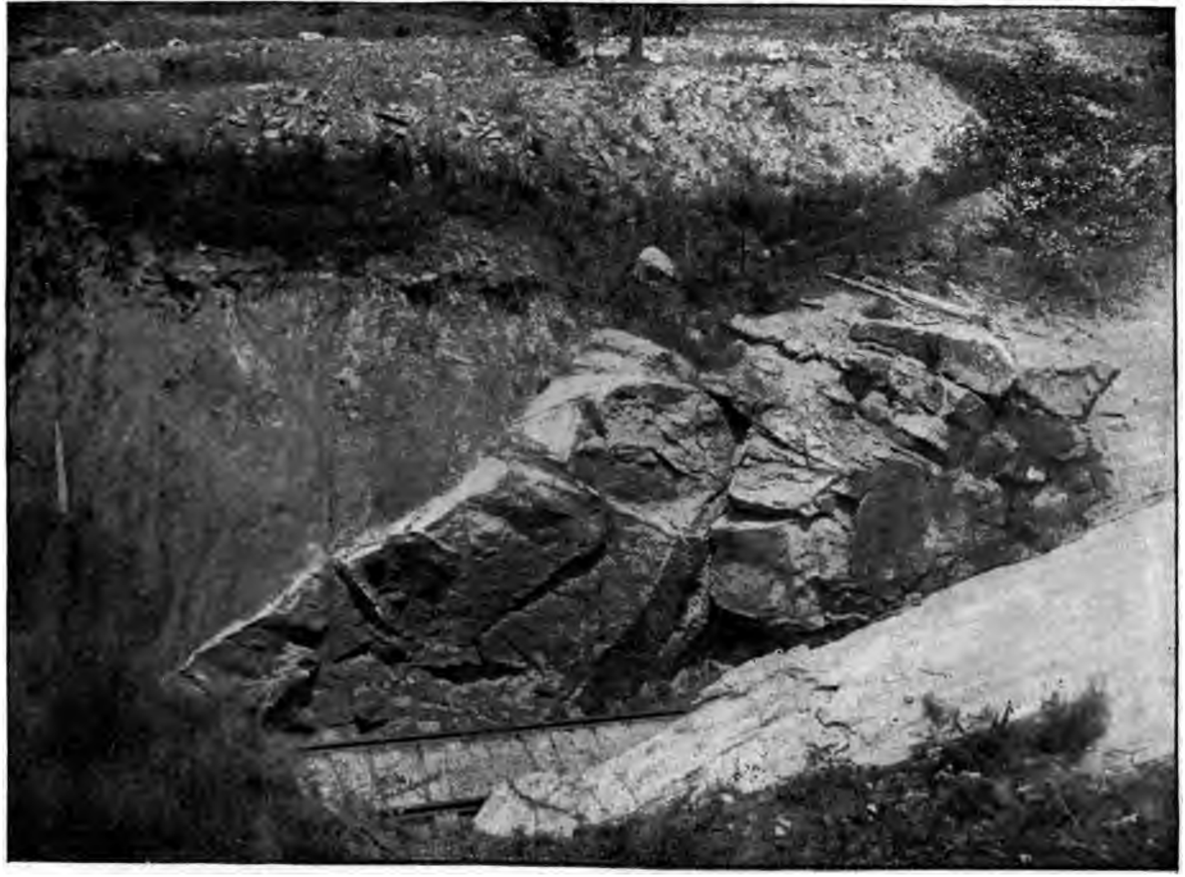
Failures in mining due to geological structure.—It is safe to say that a large part of the failures which have attended the working of the coal in the Richmond coal field are due to the faulting and crushing that the rocks have suffered. Mining has been attempted only along the immediate borders of the main area and in the small secondary basins, that is, in localities where the greatest amount of disturbance has occurred. The central and undisturbed portion has never been explored. A few drill holes midway between Midlothian and the Old Dominion mine would demonstrate whether the coal in the central portion of the field is sufficiently thick and of such a quality that it would repay mining at the considerable depth at which it occurs. While the central portion of the field is practically without faults, it is possible that it is traversed by sheets and dikes of trap, the effect of which on the coal, whether to decrease or increase its value, can not be predicted.

Absence of oil and gas.—Although mining in the Richmond coal field has been retarded by the escape of natural gas and by spontaneous combustion, the fact that it has been penetrated by mines and drill holes without developing any reservoirs of oil or gas of economic importance must be considered as sufficient evidence that such deposits do not exist. The broken condition of the strata and the attitude in which they occur are in themselves sufficient indication that reservoirs of oil and gas need not be looked for.

STRUCTURE OF THE DEEP RIVER AREA.

The most usual dip of the strata in this area is southeast at an average angle of perhaps 15 degrees. Faults are exposed in several of the excavations along the railroads crossing the area, and changes of dip occur adjacent to many of the trap dikes which break through the stratified beds, indicating that they were intruded along displacements.

On the east side of the area, near Carey, and again on the west border, a mile or two north of Egypt, there are notches in its outline which probably indicate the presence of faults. The junction of the Newark rocks and the adjacent crystalline rocks of the eastern border where it is crossed by the Piedmont Air Line Railroad, 1½ miles west of Carey, is well exposed. The Newark strata at the junction consist of a coarse, brecciated conglomerate, dipping westward and resting on the crystalline terrane from which they were derived. These coarse beds belong to the basal conglomerate of the series, and agree in all essential features with the same stratum where exposed along portions of the west margin of the same area and in adjacent secondary areas. The most remarkable evidence of faulting in this region is furnished by a narrow strip of Newark strata adjacent to the west border of the main area, immediately west of Lockville. The trend of the axis of this outlier is parallel with the margin of the main area, and distant less than a mile from it. In the central part of the strip the strata dip a little east of north at an angle of 20 degrees. On the west side of the area, and resting on crystalline rocks, is the coarse basal conglomerate of the Newark.



FAULT IN BOGAN'S CUT, NORTH

On Kerr's[1] geological map of North Carolina, three small detached areas of the Newark system are represented as occurring about 20 miles east of the eastern border of the main area and 10 miles south of Raleigh, but no observations on the character or structure of these outliers are known.

Without entering into a detailed account of observations made by the writer in the Deep river area, it may be stated that the evidence throughout is decidedly in favor of the prevailing fault structure. There is an absence of anticlinals and synclinals, and also an absence of a continuous monoclinal dip throughout the area, as has been stated.

STRUCTURE OF THE WADESBORO AREA.

In this, as in the Deep river area, the prevailing dip is southeast, but there are many exceptions in which the inclination is reversed along lines of displacements or adjacent to trap dikes. There are also outlying or secondary areas that still further illustrate the fault structure of the region.

The best section obtained in this area, and perhaps the most instructive that can be found anywhere in the Newark system, is exposed along the Carolina Central railroad from Lylesville westward through Wadesboro, to the western margin of the area. The width of the Newark rocks along this line, including two tongues of crystalline rock penetrating the sedimentary series from the north, is about 16 miles. The section referred to above, as measured during my reconnaissance in 1885, is shown on Pl. IX. On the same plate is a more detailed section of a portion of the general section, in which the characteristic structure of the Newark system is well illustrated. West of Lylesville for about 1 mile the rocks are granitic and deeply decomposed. Bordering the granite on the west are the Newark beds. The Newark strata adjacent to the eastern border of the area are composed of the débris of granitic rocks, plainly derived from the crystaline area on the east. At the immediate eastern end of the Newark section there are certain structureless, mottled clays, which were apparently deposited above the Newark strata and may possibly belong to the Potomac formation; but the relations of these deposits have not been satisfactorily determined. The dip of the Newark beds for about a mile westward from the eastern margin, as shown on the accompanying sections, is westward at angles varying from 10 to 20 degrees. The dip then changes abruptly near a trap dike, and the strata are inclined southeastward at an angle varying from 15 to 25 degrees. This general inclination prevails all the way across the remainder of the section until the crystalline rocks interrupting the continuity of the Newark beds just east of Browns creek are reached.

In this section over fifty trap dikes were observed, ranging from a few inches to over 50 feet in width, and at least fourteen displacements of considerable but usually undetermined throw were noted. As the rocks were seen for less than half the distance included in the section, there being no exposures where the railroad is constructed by filling, it is probable that less than half the dikes and faults that exist have been seen. The most typical as well as the best exposed portion of this section is in Bogans cut, about 3½ miles west of Wadesboro, which is indicated at the bottom of Pl. IX. In this cut there are four well exposed faults, besides abrupt changes in the inclination of the strata adjacent to the trap dikes. The displacements in each instance have a throw of less than 50 feet, and with one exception are normal faults, hading westward. The exception is a reversed fault, as shown in the section, a photograph of which is reproduced in Pl. XII. Comminuted rock occurs along the immediate plane of the fault, and a triangular block of sandstone is included in it. The structure in Bogans cut is rendered unusually plain by the contrast of reddish brown shales and gray sandstones brought into abrupt contact by the displacement. The fault planes in each instance are smooth and slickensided; the striations on the smooth slopes record vertical movements.

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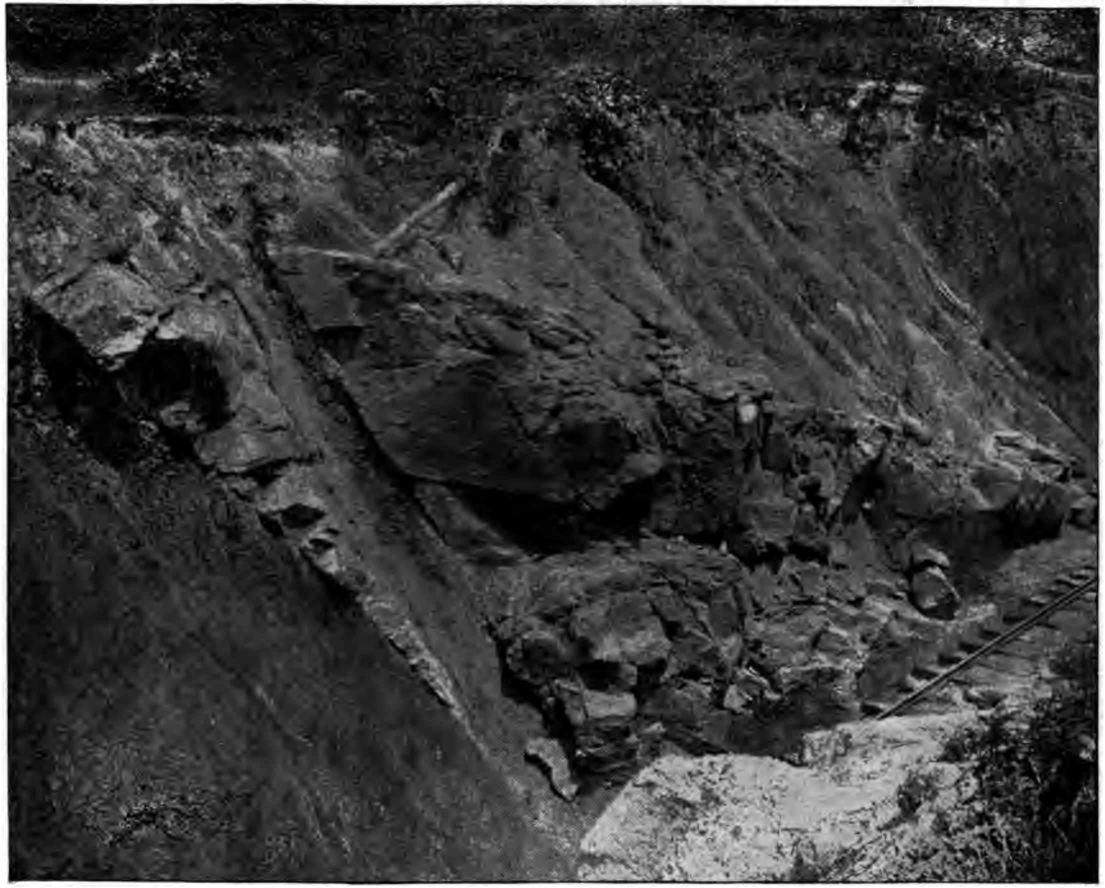
[1] In Rep. Geol. Surv. of North Carolina. Raleigh, 1875.

A mile and a half west of Bogans cut the basal conglomerate of the Newark system comes to the surface with an easterly dip of about 25 degrees, and rests on crystalline strata. West of this junction the crystalline rocks are well exposed for nearly a mile to the eastern border of the valley of Browns creek. There is then an unexposed area about a mile broad occupied by flood-plain deposits, but it is probably underlain by Newark strata. On the west border of the flood plain the Newark system again appears, dipping eastward at a high angle, and continues to be again exposed occasionally for 2½ miles along the railroad. In this portion of the section the rocks are shales and sandstones, traversed by many trap dikes and broken by several faults. The basal member of the series again appears, as shown on Pl. IX, with an easterly dip of about 40 degrees, and resting upon metamorphosed rocks. West of this junction the metamorphosed rocks form the surface for about 300 feet, when the basal conglomerate again appears, this time dipping westward at an angle of about 20 degrees. A fault between the Newark strata and the metamorphosed rocks is here plainly indicated by a band of comminuted fragments. The conglomerate on both sides of the upthrust slates is composed of the same rock in rounded and angular masses, and was evidently of local origin. West of the last exposure of the basal conglomerate, the characteristic shales and sandstones of the Newark system continue to be exposed westward along the railroad for several hundred feet. The crystalline rocks then begin and continue indefinitely.

In the section just described the basal conglomerate is exposed four times by faulting. There are also, as we have seen, many faults not of sufficient vertical extent to bring up the basal member of the system. The disturbances that the rocks have undergone are still further illustrated by the great number of trap dikes penetrating them.



FAULT IN BOGAN'S CUT, NORTH CAROLINA.

The Wadesboro area as a whole is depressed below the level of the surrounding plateau of crystalline rocks, thus indicating that the rocks composing it are more easily eroded than the surrounding terranes. When the crystalline rocks penetrate the Newark area, they form bold hills and by their relief enable one to judge of the structure of the rocks beneath. South of Bogans cut, near Whites store, there is a high north and south ridge composed of crystalline rocks traversing the Newark system, which is probably the upheaved side of a fault and may be an extension southward of the ridge which appears on the west side of Browns creek farther north.

The structure of the Wadesboro region is still further illustrated by two small outlying areas belonging to the same system. These are situated to the eastward and are indicated on Kerr's geological map of North Carolina. These were examined by the writer in 1885 and are supposed to occupy fault basins, as in the case of the numerous outlying areas previously noted. The first of these visited is about 3 miles east of the eastern border of the main area in the valley of Mountain creek. It is between 2 and 3 miles long from north to south and perhaps a quarter of a mile broad. The dip of the strata is in general southeastward at an angle of 10 degrees. South of this, and about 4 miles west of Rockingham, is another similar area, separated from the main area by about 8 miles of crystalline rock. In this intervening belt there are trap dikes identical with the numerous dikes of the Newark system, and in the Rockingham area there are other dikes of the same character. The area near Rockingham is nearly 2 miles broad, with possibly a ridge of metamorphosed rocks in the center, and coarse conglomerate is exposed along its western border. The strata above the conglomerate are normal sandstones and shales dipping eastward 15 degrees.

My notes show many other details of structure which are in harmony with the general conclusions presented above, and strengthen the hypothesis that the Wadesboro area, like others in the system to which it belongs, is characterized by diverse monoclinal structure due to the tilting of faulted blocks.

SUMMARY.

The brief account given in this chapter of our present knowledge of the structure of the Newark system, shows that it is monoclinal throughout. The structure is due to a fracturing of the rocks along lines having in general a northeasterly and southwesterly trend, and a tilting and perhaps overthrusting of the included blocks. In many instances the fault blocks are inclined in a uniform direction, and when the similarity in strata renders it difficult to detect repetitions, the system appears to be a continuous mass of vast thickness. Some of the faults observed are of sufficient magnitude to bring to the surface the crystalline or Paleozoic rocks on which the system rests. Others expose the basal conglomerate, but the greater number are small, and owing to the similarity of the strata affected by them are difficult and many times impossible to trace.

While faults are numerous, pronounced folds are absent. Broad, gentle undulations do occur, however, especially in the broader areas, and in the Connecticut valley and New Jersey, explain in part, the curvature of the outcrops of some of the trap sheets.

An examination of the entire system shows that faulting is as important an element in the structure of the Atlantic coast plain as it is in the Great basin. These two regions have this important difference, however: In the Great basin the fault scarps stand in relief and form mountain ranges, while along the Atlantic coast the relief has been subdued by erosion, and for the most part a featureless plain takes the place of the mountain uplifts that would otherwise appear.

It is to be supposed that the faults traversing the Newark rocks are but a portion of a great system which affects a large part, and perhaps the entire region of metamorphic rocks, in the midst of which remnants of the Newark system have been preserved.

ORIGIN OF FAULT STRUCTURE.

The only hypothesis that has been advanced in explanation of the characteristic fault structure of the Newark system was proposed by Davis,[1] in discussing the deformation of the rocks of that system of the Connecticut valley. Starting with horizontal Newark strata deposited on the truncated edges of highly inclined crystalline beds, Davis shows that a force of compression, acting at right angles to the bedding of the crystalline rocks, would increase their inclination and cause the beds of which they are composed to slip one on another. The eroded surface forming the floor on which the Newark beds rest would thus become faulted along lines of strike. The faults would be carried upward through the superjacent stratified beds, and produce a series of monoclinal fault blocks, the prevailing dip of which would be in one direction.

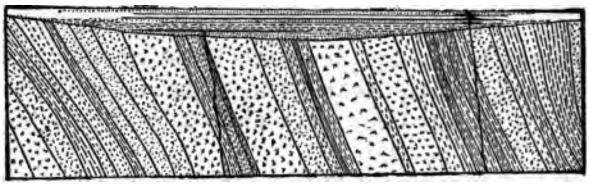


FIG. 3.—Ideal east and west sections of Connecticut valley area previous to deformation.

This explanation will be readily understood by reference to the accompanying diagram (Fig. 3), copied from Davis's paper already referred to, in which the Newark strata of the Connecticut valley are shown in the attitude they held up to the initiation of their present structure. Two dikes have been introduced, one on the left to show the supposed source

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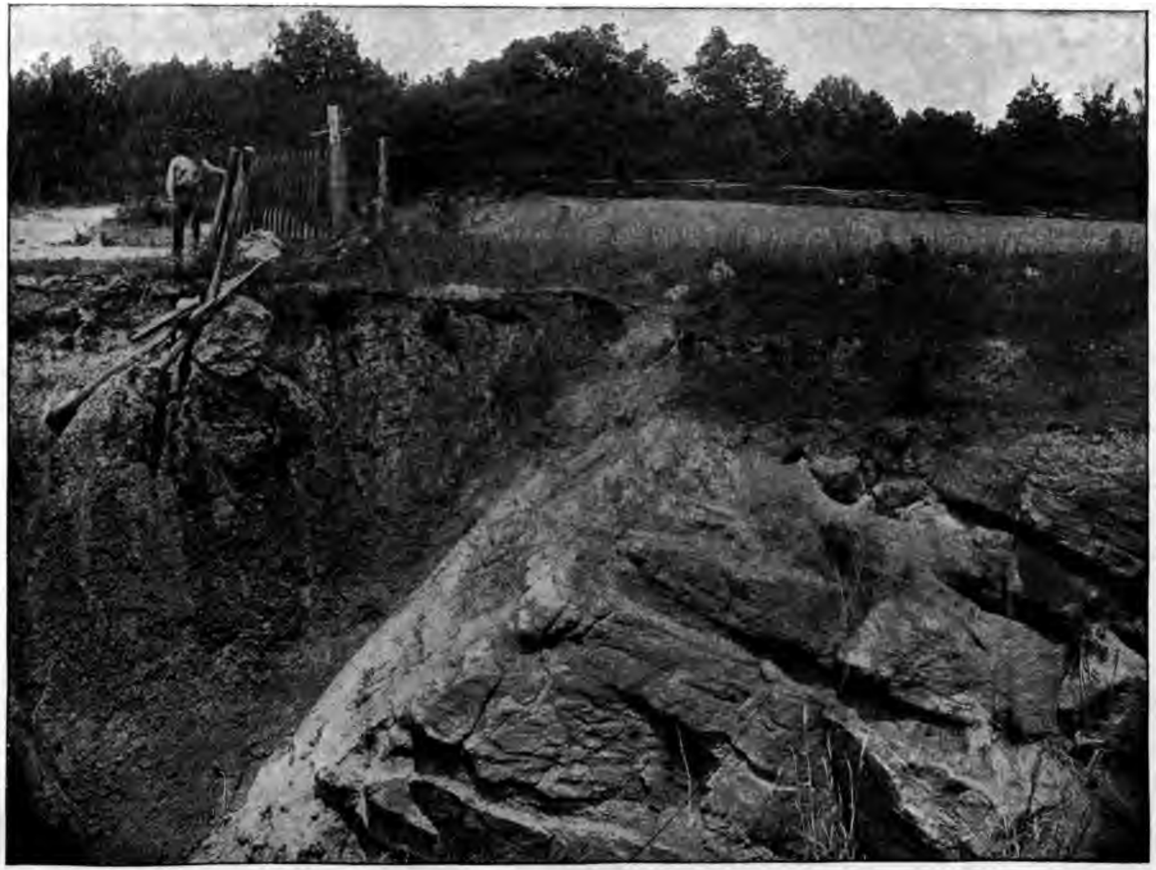
[1] U. S. Geol. Surv., 7th Ann. Rpt., 1885-'86, Washington, 1888, pp. 486-490.



FAULT IN BOGAN'S CUT, NORTH CAROLINA.

of the intruded trap sheets, and one on the right to explain the successive overflows of trap that appeared at times during the depression of the Connecticut valley area and the accumulation of the Newark strata. Deposition is supposed to have continued as long as depression was in progress, but was stopped when the fundamental schists began to be affected by lateral compression. The compression caused the strata in the schist to slip one on another, thus increasing their dips, and in some instances carrying them over beyond the vertical.

The result of the compression and slipping of the schistose layers, as postulated above, on the stratified beds resting on them is shown in Fig. 4. The slabs in the underlying schists are separated by faults, and their beveled edges are canted over at an angle equal to their change of dip. The overlying beds, unable to support themselves on this uneven floor, have been broken into fault blocks and tilted in a uniform direction.

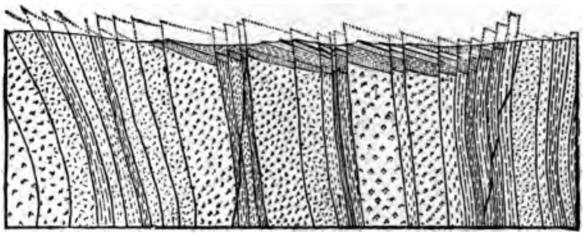


FIG. 4.—Ideal east and west section of Connecticut Valley area after deformation.

The occurrence of reverse faults has also been considered by Davis, and their origin explained by a curvature of the underlying schistose strata in place of the more regular bedding previously indicated, as shown in the following diagram:[1]

This attractive hypothesis finds some support outside of the Connecticut valley area, in the fact that the strike of the numerous faults in the Newark rocks south of Connecticut, is in a general way parallel with the trend of the strata in the associated crystalline rocks. The actual tracing of faults, however, from the Newark area into the adjacent crystalline, has not been done. The most favorable locality for continuing the study is unquestionably the Wadesboro area, where the structure of the crystalline floor beneath the Newark system can be determined with some degree of accuracy, and the conditions for tracing faults from stratified to crystalline rocks are better than in any other area.

As shown in a preceding section of this paper, a general study of the structure of the Newark system should include the consideration of the origin of the trap dikes and sheets which traverse it. Like the faults, these are due to a disturbance and breaking of the strata. While it is highly probable that the faulting and injection of igneous rocks are portions of the same process, yet this has not been proved. It may be presumed, if the subsidence of the region of accumulation in Newark times was due to displacements, as is suggested by marginal faults along the borders of certain of the areas, that the contemporaneous overflows of igneous rock came to the surface through fissures thus formed. Subsequent faulting may have been accompanied by the injection of dikes and intrusive sheets. If such an association of faults and trap rock can be shown it follows, on the hypothesis of the origin of the faulted structure proposed by Davis, that the trap dikes in the crystalline area should follow lines of bedding. Observation in this connection is very incomplete; but so far as is known the dikes referred to do not follow the lines of bedding, but cross them in an irregular manner.

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[1] F more recent discussion of the structure of the Connecticut valley area see an article by J. D. Percival's map of the Jura-Trias trap belt of central Connecticut, with observations on ing or mountain-making disturbance of the formation. Am. Jour. Sci., 3d ser., vol. XLII, Pl. XVI.

CHAPTER IX.

FORMER EXTENT.

Considerable diversity of opinion has arisen concerning the original extent of the rocks of the Newark system. The conclusions of geologists in this connection fall in two groups: First, those implying that the present detached areas of the system are local deposits which were originally but little, if any, greater than at present; second, those implying that the detached portions of the system as they now exist are remants of terranes much larger than any of the areas now remaining, a very large and perhaps the greater part of the original deposits having been removed by erosion. For convenience the common element of the first group of explanations will be called the ***local-basin hypothesis***, and that of the second group the ***broad-terrane hypothesis***.

THE LOCAL-BASIN HYPOTHESIS STATED.

This hypothesis has been advanced more or less definitely by a number of writers.

In describing the rocks of the Newark system about the Bay of Fundy, Dawson[1] states that when they were deposited, the form and contour of the country already made some approach to what it still retains, and that the sedimentary strata were deposited in a bay coinciding with the present Bay of Fundy, but a little wider and larger.

The Connecticut valley area and the much larger New York-Virginia area are also considered by a number of geologists as representing about the original boundaries of the estuaries or lakes which became filled with sediment during the Newark period.

This view is expressed by Newberry[2] in an essay on the geological history of New York, island and harbor, in the following language:

> The trough between the New York axis and the Blue Ridge was occupied by water, and in this trough the Triassic [Newark] shales and sandstones were deposited. A similar trough east of New York, where now is the valley of the Connecticut, was also a lagoon or estuary in which similar sediments accumulated.

These conclusions are again stated in a recent monograph of the fossil fishes and fossil plants of the rocks under consideration.[3]

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[1] Acadian Geology, 3d. ed., 1878, pp. 86, 87.

[2] Pop. Sci. Monthly vol, XIII, 1878, p. 644.

[3] U. S. Geological Survey, Mon., vol. XIV, 1888, p. 6.

Somewhat similar conclusions have been reached by Davis,[1] and may be found in his recent contribution to the study of the structure of the Connecticut valley region.

The most definite statement of the local-basin hypothesis that has been published is Emerson's graphic description of the condition of the Connecticut valley at the time it received its filling of sandstone:[2]

> If one will picture the broad valley [of the Connecticut] from Pelham across to Westhampton [Massachusetts] as a half mile deeper than the present river, and imagine the rocky surface of the upland as half a mile higher than now, with the canal-like channel filled by the fiord waters to a height above the level of Mount Holyoke, while the bordering streams swept sand and gravel into the basin and strong currents spread the material over its bottom, he will have a rude outline of Triassic [Newark] times in the valley.

The picture suggested by this clear description is of a plateau region cut by a profound canyon a mile in depth, where now the Connecticut flows.

Percival[3] remarks that the two Newark areas of Connecticut are of a local, isolated character, each forming a complete system in itself, and apparently independent of any more extensive formation.

Dana[4] has expressed the opinion that the Connecticut valley was an estuary during the Newark period, and had its violent floods, which may have been for a part of the time enlarged by the water and ice of a semiglacial era. J. Le Conte[5] also considers the Connecticut valley to have been a restricted basin during the Newark period.

The small Newark areas in Virginia and North Carolina, which contain coal, have been regarded as owing their origin to the filling of local basins which were swamps during portions of the Newark period.[6]

Similar opinions have been expressed more or less definitely by other writers, but without making further quotations I will attempt a general statement of the local-basin hypothesis:

During the Newark period the Atlantic border of the continent was about in its present position, and the land had about its present relief. Then, as now, there was a Piedmont plain, and in this plain there were long, narrow basins, formed in the region of the Connecticut by erosion, apparently, but in the other cases probably by orographic movement, which held lakes, or being connected with the ocean, formed estuaries, fiords, etc. Into these basins the debris from the adjacent land surface, composed of crystalline rocks, was carried and deposited. Since the filling of the basins the strata accumulated in them have been tilted, but beyond this there has been no pronounced orographic movement and no very considerable amount of erosion.

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[1] U. S. Geological Survey, Seventh Ann. Rept., 1888, pp. 461–462.

[2] In Gazetteer of Hampshire county, Massachusetts. [From] 1654–1887. Compiled by W. B. Gray, Syracuse, New York. [1888] p. 18.

[3] Rept. Geol. of Connecticut, 1842, p. 430.

[4] Am. Jour. Sci., 3d ser., 1879, vol. XVII, p. 330.

[5] Elements of Geology, 2d ed., 1882, p. 453.

[6] Richmond Coal Fields, Virginia, by W. Clifford, Manchester [England] Geol. Soc. Trans., vol. XIX. *1888, p. 333.*

THE BROAD-TERRANE HYPOTHESIS STATED.

The former connection of various Newark areas south of New York was implied in the explanation of the origin of the prevailing dips exhibited by these rocks in New Jersey and Pennsylvania, advanced by Rogers,[1] in 1840. This author states that the rocks referred to seem to have originated in a long, narrow trough, which had its source as far south at least as the eastern base of the Blue Ridge in Virginia and North Carolina, and probably opened into the ocean somewhere near the present position of the Raritan and New York bays.

The former extension of the rocks of the Newark system beyond the boundaries of the areas now remaining, although suggested by Maclure[2] as early as 1817, seems to have been first clearly indicated by Kerr,[3] who sought to explain the opposite dips of the rocks of the Deep river and Dan river coal fields of North Carolina on the hypothesis that the two areas were formerly united and owe their separation to the upheaval and erosion of the belt of country between them, the portions remaining being in a general way of the nature of bordering or basal remnants of a great anticlinal.

The union of the various areas south of New York, in which sediments were deposited during the Newark period, into one great estuary having its capes at Trenton, New Jersey, and Manhattan Island, New York, has been suggested by Lesley.[4]

The hypothesis proposed by Kerr in reference to the former union of the Deep river and Dan river coal fields, was received with favor by Bradley,[5] who extended it to the Connecticut valley and the New York-Virginia areas. Some arguments tending to show that the rocks of the Newark system in New Jersey and in the Connecticut valley were originally connected were advanced by the present writer several years ago, and need not be restated.[6] The various areas of the Newark system in Virginia, according to Heinrich,[7] were formerly connected, and their continuity was broken by a slow and unequal movement of the floor of crystalline rocks on which they were laid down, accompanied by the erosion of the elevations thus formed.

Briefly stated the broad-terrane hypothesis claims that the various areas of the Newark system now remaining are remnants of much broader terranes, and that many and perhaps all of them were originally united. More than this, the hypothesis implies that marked orographic movements, accompanied by upheaval, faulting, and diking, have affected the beds since they were deposited, and that they have suffered very greatly from erosion.

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[1] Description of the Geol. of New Jersey, final report, Philadelphia, 1840, 12mo., p. 115.

[2] Observations on the Geology of the United States, Philadelphia, 1817, p. 41.

[3] Rep. of the Geol. Surv. of North Carolina, vol. I; Raleigh, 1875, p. 141.

[4] Cited in Coal Regions of America, by J. Macfarlane, 3d ed., New York, 1877, p. 512.

[5] Am. Jour. Sci., 3rd ser., vol. XII, 1876, p, 289.

[6] New York Acad. Sci., Ann., vol. I, 1878, p. 220-244; also in Amer. Nat., vol. XIV, 1880, pp. 703-712.

[7] Am. Inst. Mining Eng., Trans., vol. VI, 1879, pp. 227-274.

With this brief statement of the case let us endeavor to determine on what facts the two hypotheses rest.

EVIDENCE FAVORING THE LOCAL-BASIN HYPOTHESIS.

No definite statement of observations tending to show that the various areas of the Newark system did not extend much beyond their present boundaries has been made and perhaps should not be expected. That the various areas are now isolated, and are formed of débris derived from crystalline rocks of the same character as those now bordering them, seems to be all the direct evidence there is that they were originally deposited in independent basins.

In reference to the Connecticut valley area, W. M. Davis states that "its original area was greater than at present, as there has been demonstrable loss by marginal erosion, but it is generally thought that the loss has not been very great." In continuing the discussion he says:[1]

> We are not, however, confined to this conclusion by a very strong line of argument. The rapid change from finer standstones and shales which generally appear in the central part of the formation to the coarse sandstones and conglomerates that characterize the margin is usually cited as implying a narrow limitation of the area of the deposits, but it is not yet demonstrated that the finer central strata are the equivalents of the coarser marginal layers. The latter may mark localities on the advancing shore during submergence that were favorable to the formation of coarse deposits, while the former may correspond to a later date of more general submergence; moreover, in some cases the finer shales approach close to the present margin of the formation. No isolated outliers of the formation have yet been discovered, unless the little Southbury-Woodbury area in western Connecticut be so regarded, but the region around the area that is still covered by the Triassic [Newark] rocks has been elevated to an altitude and during a time sufficient to have suffered much loss by post-Triassic erosion. The general freedom of the same surrounding region from the igneous rocks so closely associated with the Triassic formation in its various areas along the Atlantic slope may also suggest its escape from Triassic submergence; but in our present state of knowledge concerning the cause of this peculiar association it can hardly be employed in this argument. It therefore does not seem impossible that the original Triassic area may have been much larger than the present, but the burden of proof lies clearly in those who would contend for what now appears to be so far beyond the necessities of the case.

EVIDENCE FAVORING THE BROAD-TERRANE HYPOTHESIS.

The data on which this hypothesis rests have been presented in the preceding pages, and although it is not necessary to reassemble it, we may designate the classes into which it naturally falls. *First.* The stratigraphic incompleteness of all of the Newark areas now remaining. *Second.* The presence of marginal faults which have determined the limits of some of the areas in certain directions. *Third.* Evidence of great erosion since the Newark rocks were deposited.

It is well known that when water basins become filled by sediment washed in from the shores, the material deposited has an orderly arrangement, the coarser portions being dropped near shore, while the finer portions are carried farther out. The slow subsidence of a basin which is being filled in this way would result in the formation of a basal conglomerate with layers of fine sediments superimposed upon it. A horizontal section of such a deposit taken at any horizon above the basal conglomerate first laid down would show a central area of fine material surrounded by a fringe of coarse detritus.

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[1] Seventh Ann. Rep. U. S. Geol. Survey, 1888, pp. 461-462.

In no instance in the various Newark areas now remaining does such an arrangement appear. Along portions of the margins of some of the areas referred to coarse deposits are found, but in other parts of their borders the rocks are fine grained and of the nature of off-shore deposits. The necessary conclusion seems to be that the terranes now remaining do not represent the original extent of the deposits at any stage.

The presence of faults along the margins of several of the Newark areas show that their present limits have, in part at least, been determined by displacement and subsequent erosion. The marginal faults referred to frequently bring fine grained Newark rocks in direct contact with bordering areas of crystalline rock, thus proving conclusively that the original extent of the sedimentary beds was beyond the limits indicated by this present outcrop.

Evidence of great erosion since the Newark period is furnished by the topographic relief of the outcropping edges of intruded trap sheets, which were originally forced in among the sedimentary beds and cooled far below the surface. Since their intrusion, the system has been tilted and reduced nearly to a base level by subærial erosion. To bring about the conditions now prevailing very large portions of the original deposits must have been removed.

The occurrence of soft strata of shale and sandstone dipping in one uniform direction over large areas, which are now nearly at base level, demonstrates that much erosion has taken place. The amount of this erosion can not be quantitatively determined, but I think that every geologist who has studied the matter will agree with me that many hundreds and possibly thousands of feet of strata have been removed from the areas in question. This again implies that the areas now occupied by the system are remnants of the original deposits.

The Potomac formation rests unconformably on the Newark, the unconformity being due to the erosion of the lower rocks previous to the deposition of younger beds upon them.[1] There is also evidence that the Newark rocks were again exposed to erosion previous to the deposition of the Cretaceous. Another elevation of the Atlantic sea border, followed by a reduction to base level, followed the deposition of the Cretaceous rocks, and removed them from large areas now occupied by the

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[1] Three formations of the Middle Atlantic Slope, by W. J. McGee. Am. Jour. Science, 3d series, vol. xxxv, 1888, p. 135.

Newark system, as has been quite clearly demonstrated by Davis.[1] During these various stages of erosion when the country, occupied in part by the Newark system, was being reduced again and again by sea level after upheavals, all of the Newark rocks above the horizon of base-level erosion were cut away. The portions now remaining appear to owe their preservation, as previously stated, to their having been depressed along lines of displacement below the horizon at which subærial agencies could act.

The considerations mentioned, and some others which are more difficult to state briefly—as the relations of drainage on the Atlantic slope to the Newark areas, and the absence of overflow of volcanic rock on crystalline and Paleozoic terranes surrounding the islands occupied by the Newark system—all tend in one direction, and furnish cumulative evidence tending to show that the Newark rocks were formerly much more extensive than at present, and that many of them must have been united.

OBJECTIONS TO THE BROAD-TERRANE HYPOTHESIS.

Although the broad-terrane hypothesis has met with but a limited number of adherents, only a few specific objections have been made to it.

Newberry[2] observes that it seems scarcely probable that some thousands of feet of Triassic [Newark] rocks, including thick beds of hard and resistant trap, should have been so completely carried away from the interval of 100 miles now separating the Connecticut valley and the New York-Virginia areas that not a trace of them should anywhere be left. It should be borne in mind, however, in this connection, that an outlier—the Southbury area—does exist in the interval mentioned. This area is shown on Pl. III. It is situated 16 miles west of the west border of the Connecticut valley area, and probably owes its preservation to its having been depressed below the plane of base-level erosion to which the country has been reduced and to the numerous sheets of trap which traverse it. Whether other trap sheets existed in the interval mentioned is not known, and but scanty suggestions that such was the case can be derived from such studiesof this area as have been made.

It is implied in the objection cited above, that trap rock is much more difficult of erosion than the sandstones and shales with which it is associated in the Newark system. Under such climatic conditions as now prevail in Virginia and North Carolina this is not the case. The trap dikes are there deeply decayed, and frequently so soft, even at a depth of 50 feet from the surface, that they can be molded in one's fingers like potter's clay. Instead of forming prominent ridges their presence is not indicated in the relief of the country.

Not only are dikes under certain conditions easy of erosion, but it is an accepted principal in geology that the amount of erosion in any region depends on time and opportunity rather than on lithological conditions. Were the rocks of the Newark system, including thick sheets of trap, elevated sufficiently to secure rapid transportation, their erosion would be certain. The laws of subærial decay and erosion apply to hard as well as to soft rocks; the length of time required for the removal of hard beds is great, but is not infinite.

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[1] The Geographical Development of Northern New Jersey, in Boston Soc. Nat. Hist. Proc., vol. XXIV, 1889, pp. 265–427.

[2] *The Geol. Hist. of* New York Island and Harbor. Pop. Sci. Monthly, vol. XIII, 1878, p. 646. Also *U. S. Geol. Survey*, Monograph vol. XIV, 1888, p. 6.

The Cretaceous rocks of Long Island, it has been observed by Newberry,[1] rest directly on the crystalline schists, with no trace of the Newark system between. It is claimed that "this would indicate that the Trias [Newark] of the New Jersey basin never reached over that portion of the divide."

On a previous page of this paper I have cited evidence which shows that the rocks of the Newark system were upheaved and eroded to a base level before the deposition of the Potomac formation or the Cretaceous. Beneath portions of the Cretaceous of New Jersey, near its western border, as has been shown by Cook,[2] only a few feet of Newark sandstones and shales intervene between the Cretaceous and the crystalline rocks. This remnant is of fine material, not a coarse shore deposit. The absence of the Newark system in a similar position on Long Island seems clearly to indicate that the pre-Cretaceous erosion was there a little more complete than at the locality referred to in New Jersey.

The conclusion that there was a line of elevation through New York, Trenton, etc., after the Newark period and before the deposition of succeeding formations, certainly seems to be warranted from our present knowledge of the region. That this line of elevation has undergone post-Cretaceous movement is indicated by the present attitude of the Cretaceous beds.

CONCLUSION.

My conclusion from a study, not only of the writings of all who have published on this subject, but from personal observation, is that each of the Newark areas was originally much larger than now, and that there is a strong probability that all of the areas between Massachusetts and South Carolina were originally united. It is quite possible, also, that this great area was connected with the Acadian region, but observations to support this hypothesis are wanting.

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[1] U. S. Geol. Survey, Monograph vol. XIV, 1888, p. 6.

[2] U. S. Geol. Survey, Monograph vol. IX, 1885, p. x. See also record of wells at Perth Amboy, N. J. Geol. Survey of New Jersey, Ann. Rep. for 1885, p. 111.

CHAPTER IX.

CORRELATION.

GENERAL PRINCIPLES.

The phenomena by means of which the relative age of terranes may be more or less definitely determined are of two principal classes, physical and biological.

PHYSICAL PHENOMENA AS A BASIS OF CORRELATION.

The physical evidence on which strata may be correlated is of varied character, but in general may be classed in the divisions given below:

Superposition.—The simplest case in which the relative age of strata may be determined is when they are comformably superposed one upon another. The highest in the series is then the youngest. The relative position of beds as is well known may be modified or even reversed by folding, faulting and overthrust, and in the correlation of strata by vertical sequence these modifying conditions have to be eliminated. Overflows of volcanic rocks and ejections of volcanic ash may play the role of sedimentary beds and form a time record by means of which the relative age of terranes not themselves in contact may be determined.

Contained fragments.—One series of rocks may contain recognizable fragments of another series. Manifestly the strata containing such fragments are newer than the strata from which they were derived. This is a common means of determining the relative age of conglomerates and is applicable also in some instances to volcanic rocks.

Relation to systems of folds, faults and dikes.—The relative age of rock series not in direct contact may sometimes be shown by their mutual relation to widely spread geological structure. For example, in the Appalachians a characteristic structure has been impressed upon the strata from the Coal-measures downward; consequently any rocks in this region not affected by the corrugations characteristic of the Appalachian structure, may be assumed to be of later date than the Coal-measures. In a similar way the relation of strata to a well determined series of faults or to a persistent system of dikes may be of service in indicating their relative age.

Relation to unconformities.—A series of rocks resting unconformably on a lower series in one region and conformably on a lower series in another region, the relative age of the two lower series may be inferred.

In such an instance the lower bed conformable with the upper would be expected to be later than the unconformable lower series, for the reason that great unconformities result from slow changes and are wide reaching in their effects. They leave a record which provisionally, at least, may be used as a time record. The conditions here postulated, while serving as a suggestion to the field geologist, would require additional evidence before being accepted as a definite means of correlation.

Relation to glaciation.—Widespread glaciation, by leaving characteristic records, enables the geologist to separate the beds deposited before its occurrence from those of subsequent date.

Lithological similarity.—The identity in age of various strata is sometimes suggested by their lithological similarity, but this is an uncertain indication, and except in regions of limited extent is apt to lead to erroneous conclusions. The lithological character of clastic rocks may depend on the physical conditions under which the debris composing them was formed. For example, the conditions which influence the disintegration of rocks are wide-reaching, and the characteristics of the rocks resulting from the assorting and deposition of such debris may be sufficiently constant over wide areas to be of assistance in determining relative age. To illustrate, the rocks forming the surface may suffer decomposition over a region of broad extent, and the resulting debris acquire certain characteristics, as a uniform red color, for example, due to the incrustation of ferruginous clay on the grains composing it. The removal and deposition of this incrusted material might produce rocks of similar appearance over broad areas and even in separate basins.

Rocks subjected to heat, pressure, crust movement, etc., have frequently acquired a schistose structure, due to rearrangement of the mineral matter composing them—that is, they are metamorphosed. Such alterations have been used as a basis for deciding on the age of strata, nearly all metamorphosed rocks having formerly been considered as Archean; but it is now known that strata of any age may have undergone the changes referred to above. Conditions may be postulated, however, under which metamorphism might be of service in determining the relative age of terranes. For example, a metamorphosed terrane may be considered as the record of a wide-reaching physical and chemical change, thus making a definite time record. Terranes found by contact or by contained fragments to be younger than the metamorphosed terrane may be assumed to be younger than other terranes with which they are not in contact, but which can be proved to be of the same age as or older than the metamorphosed terrane. True, the metamorphism of even the same stratum might not be confined to a single period, but to the field geologist such an association as suggested above would furnish a working hypothesis to be proved or disproved by additional evidence.

Summary concerning physical phenomena.—Besides direct contact of terranes and the evidence furnished by included fragments, which are the most definite means of correlation, the relative age of the elements in a geological series may be determined more or less accurately by their relation to physical events which were wide-reaching in their effects; among these the most common are folding, faulting, diking, volcanic eruptions, metamorphism, and glaciation. The degree of confidence to be placed on correlations depending on relations to these phenomena must be determined by the nature of the evidence in each case. Close correlation of strata, except by contact and unbroken stratigraphical succession, is not possible by means of the relations here indicated, but when these various methods are taken in connection with other records, they become important.

Chemical phenomena considered.—The classification of volcanic rocks, spring deposits, precipitates from inclosed lakes, etc., according to their chemical composition, is fruitful of results, but is foreign to the present discussion. The chemical changes involved in disintegration, decomposition, lithification, etc., may be included under lithological characters. In the lithological comparison of clastic rocks their mineralogical and chemical characteristics are considered, but the classification of strata with reference to relative age, on purely chemical grounds, has not been found practicable.

A sequence in chemical changes might accompany the cooling of a molten globe and result in the formation of a stratified crust having a definite chemical arrangement, but that such was the case with the earth has not been determined.

In the correlation of ordinary sedimentary beds chemical may be included with physical phenomena, and need not be separately discussed at this time.

LIFE RECORDS AS A BASIS OF CORRELATION.

The study of fossils has shown that life began on the earth in low, simple forms, and progressed with unbroken continuity throughout all subsequent geological ages, with the production of higher and higher forms and greater and greater specialization as it advanced. During this development many forms became extinct and were succeeded by other forms. The length of time during which individual species were persistent was sometimes short and at other times embraced geological ages; sometimes they even extended throughout nearly the entire life history of the earth. Biology thus furnishes a record extending from the dawn of life to the present day, by means of which the relative dates of various physical changes may be more or less definitely determined. It has been assumed that this record affords a ready and infallible means of determining the age of all rocks in which organic remains occur. This seemingly simple and direct method of correlation, however, has many limitations which it will be well to glance at before attempting to apply it.

Imperfections of the geological record.—Throughout the time that life has existed on the earth there has been land and water, and the land, wherever it appeared, has been subjected to disintegration and erosion. The débris thus formed has been carried into the sea and into lakes and contributed to the formation of sedimentary deposits. In these deposits the remains of plants and animals have been buried and preserved. Large portions of the strata with these records impressed upon them have been raised above the ocean and subjected to denudation, and the material removed from them contributed to the formation of later deposits, in which other life records were preserved. In many cases these later deposits were, in their turn, upheaved and another cycle of erosion and deposition initiated. In this way large portions of the material composing stratified rocks has been worked over and over and large portions of the life records obliterated. Again, large portions of the sedimentary rocks have been metamorphosed and all their fossils destroyed. In other instances the strata have been subjected to pressure and to the passage of solutions through them, and their organic records crushed and obliterated or removed in solution. The lack of dense tissues in many animals and plants renders it evident that the preservation of any records of their existence, even under the most favorable conditions, must be an extremely rare event; for this reason, if for no other, our knowledge of past floras and faunas must always be incomplete.

The life records, as we now find them, are also imperfect, owing to the fact that many animals and plants, especially those inhabiting the land, did not live in situations where their remains were likely to be preserved. The deep sea, also, has its fauna, which, owing to the slowness with which sedimentation takes place in the depth of the ocean, and to the persistence of oceanic basins, is even of rarer occurrence in a fossil condition than the fauna of the land. The animals whose remains are most frequently found in the rocks are those that inhabit the littoral zone, where sedimentation has always been the most active and where slow subsidence is frequently in progress.

In these several ways, and in others that might be mentioned, the records of the succession of plant and animal life found in the rocks are incomplete and fragmentary. It is not necessary at this time to do more than glance at this subject, as it has been ably treated by many writers, especially by Darwin, and the term "incompleteness of the geological record" has acquired a well understood meaning.

Imperfections of our knowledge of the geological record.—Besides the incompleteness of the geological record itself, there is the incompleteness of our knowledge of that record, such as it is, which must be considered in attempting to generalize upon the life history of the earth as now known. No better proof that our knowledge of the geological life record is incomplete can be asked than the volumes on paleobiology filled with descriptions of new forms of life which appear from year to year in increasing instead of diminishing numbers. Explorations in all parts of the earth are constantly bringing to light not only new species but new genera and new families, while our knowledge of the distribution of forms already known is constantly being modified and extended.

The fact that the greater part of the earth's surface is occupied by the sea shows that large portions of the life record lie so completely beyond the limits of search that man can never hope to see them. When it is remembered, also, that large portions of the land surface of the earth are geologically unexplored, and that new fossils are being found from year to year in those portions most thoroughly examined, the imperfections of our knowledge of the imperfect geological record becomes apparent.

Influence of distribution on the life records.—The usefulness of the life history of the earth as a means of correlating geological terranes is still further complicated by a principle inherent in life itself; that is, development has been in progress but has not taken place uniformly over the whole earth, but with local modifications depending upon local environment.

Whether life began at one or many centers there is no definite proof, but assuming as the simplest postulate that it spread from one center and during the lapse of ages expanded over the whole earth, advancing at the same time to higher and higher stages of development, the specific forms in various regions would, according to the principles of natural selection, be influenced and modified by the local conditions under which they live. Under similar conditions in various regions more or less similar forms would appear. The modified forms thus arising would, in their turn, originate new centers of distribution and lead to the establishment of distinct colonies, from which in their turn, again, new forms would be propagated.

The laws of development now accepted by biologists render it evident that life has not been uniform, the world over, at any one period; hence if sedimentation had been continuous over the whole earth, the organic remains entombed at any one time would have been diverse in various regions. We know from the distribution of organic forms at the present day that variations in temperature, changes in the character of the sea bottom, the abundance or scarcety of food, and many other conditions determine the character of the organic remains now being imbedded in sediments. Even in different portions of the same strata within limited areas the organic forms are diverse. These considerations and others that might be enumerated seemingly indicate that the life record has too many modifying conditions to render it available as a basis for geological correlation.

On the other hand, it may be urged that development in many instances has been exceedingly slow and that genera and even species of plants and animals, especially in the earlier stages of the earth's history, became widely spread, and hence afford a means of determining what strata were deposited at more or less definite periods in the life history. Taken in its general meaning, this proposition can not be advantageously disputed. It has been shown, however, that the appearance and disappearance of the same species or the same genera in widely separated regions could not have been the same. Species, and even genera and families, might become extinct in the region where they first appeared long before their migrations had carried them to distant regions. Hence the discovery of identical fossils in the rocks of two widely separated regions is not considered as proof of their identity in age, except within certain broad limits. This subject was long ago discussed by Huxley, who showed that rocks containing the same species of fossils at widely separated localities, while not necessarily of the same age, hold homologous positions in relation to the development of life, and proposed the word "homotaxis" in place of the term "contemporaneity" frequently used.

The life record continuous.—The value of paleontological evidence as a means of geological correlation may be considered in another way. As previously stated, the life current has been unbroken from the time of its first appearance to the present day. Development from a humble beginning has led to the gradual productions of higher and higher forms and an equally gradual extinction of species, genera, etc. It is thus evident that if a complete and unbroken record of the life history of the earth had been preserved, it would be continuous, without sharply defined natural divisions, from end to end. It may be asked, how is it possible in such a record to draw the lines connecting groups, systems, series, etc., as at present understood? Where would the limit between Paleozoic and Mesozoic, or between Mesozoic and Cenozoic, occur?

As a matter of fact, the physical breaks in the life record have been the principal means of establishing divisions in the scale. The greater the imperfections of record, the more important have been the divisions. In various land areas this system has been found not only practicable but highly advantageous. Next to vertical sequence of terranes, it is without question the most valuable means of correlation available. It has been assumed, however, that the breaks in the life records in one region agree in time with similar breaks in distant regions. Here lies the principal objection that can be raised to the manner in which the method has been applied.

This brings us to the consideration of the standard of geological correlation first used.

The European standard.—The fact that the life record of terranes in widely separated regions, although perhaps containing the same species of plants and animals, can not be considered as contemporaneous, except in a very broad sense, has already been referred to. We have also seen that even in regions of limited extent the lithological characters frequently of the same stratum undergo important changes and are accompanied by changes in the fossils found in it. When we add to these the further considerations that the rock series in no two regions can reasonably be expected to have the same sequence or to have been subjected to the same conditions of sedimentation, or affected by the same physical breaks, it is apparent that neither the succession of organic forms nor the succession of strata found in one region can be expected to occur in the same sequence in other regions. Hence the fallacy of assuming that the succession of life, the succession in sedimentation, or the physical breaks in any one region can be adopted as a rigid standard for comparison in other regions becomes apparent.

That geology was first studied in Europe is an accident so far as correlation is concerned, by which the succession of fossils and of strata there found have been assumed by many as a standard for all other regions. The error of this assumption has been pointed out by many writers, but the practice of attempting a detailed correlation of the rocks of distant regions with those of Europe, on the evidence furnished by fossils, sometimes of very indefinite character, is continued. The history of the numerous and persistent attempts that have been made to correlate the strata of America with those of Europe, even down to the smaller divisions of the scale, on the evidence indicated above, is a chapter of confusion, controversy, and failure. No better example of the diverse conclusions arrived at when such correlations are attempted can be asked than the history of the discussions that have occurred over the correlations of the Newark system, some account of which is given in the succeeding pages of this paper.

An essay on the flora of the Richmond area has come to hand, which illustrates the method followed by many paleontologists in attempting to correlate widely separated terranes. The paper referred to is a review of Fontaine's Monograph on the Older Mesozoic Flora of Virginia, by Stur,[1] director of the geological survey of Austria-Hungary, but contains also the results of an examination of a box of fossil plants from the Richmond area sent to him for comparative study. As determined by Stur, many of the fossil plants from the Richmond coal mines are specifically identical with those occurring in the Lettenkohlen group of Germany. The confidence placed in this evidence as a basis for detailed correlation between terranes of America and Europe is expressed in the following translation of an extract from the paper referred to:

> From the foregoing it becomes evident that even on the first comparison, made with no great care, between a box of American specimens and our specimens in hand, Clover Hill on the one hand and the Lunz sandstone on the other, have a great number of plant species in common, and should, therefore, be regarded as contemporaneous, particularly as most of the species that have thus far been regarded as peculiarly Virginian, are precisely the ones found at Lunz. The species enumerated,

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[1] Die Lunzer (Lettenkohlen) Flora in den "older Mesozoic beds of the Coal Field of eastern Virginia." In Verhandlungen der k. k. geologischen Reichsanstalt, Nr. 10, 1888, pp. 203-217. The passages quoted were translated by Robert Stein, of the U. S. Geological Survey.

> however, show also that Clover Hill comprises, besides the Lunz sandstone, also a part of the flora of the bituminous slate of Raibl (p. 211).
>
> Thus we have recognized in the coal field of Richmond representatives of the Weng slate, the Aon slate, the Reingraben slate, the bituminous slate of Raibl, and the Lunz sandstone, that is, the equivalent of the Lettenkohle group of Germany.
>
> What lies under it should represent the German Muschelkalk, possibly also the the Bunter Sandstone, while the roof of the Richmond Coal-measures should represent the German Keuper.
>
> This remarkable result, furnishing a starting point for continued studies of the deposits that have been compared and identified and declared contemporaneous, could be obtained only through the assistance of our Washington geologists * * * (p. 212).
>
> The result obtained is of a nature to set forth the utility of the procedure employed in this case.
>
> I must not allow this occasion to pass without drawing further conclusions from the results obtained; that the flora of the Lunz strata, that is, of the Lettenkohle, appears in perfect identity at Richmond, Virginia, at a vast distance from the northern margin of the Alps.
>
> This shows * * * that as late as the time of the Lettenkohle, the species of the flora then prevailing possessed an enormously vast distribution on an area of whose dimensions we may form an idea by drawing an air line drawn between Vienna, Germany (Lettenkohle), and Richmond, Virginia (p. 212).

Near the end of the essay, another passage, bearing on the correlation of American terranes, reads as follows:

> * * * I am convinced that shipments of plants from the American Culm and Carboniferous, which may possibly be sent to me, will enable me to demonstrate the various divisions and series of strata in that country, just as I was enabled, by the shipment of Lunz plants from Richmond, to define the age of the Older Mesozoic flora on the James river in Virginia (p. 216).

Concerning the actual identity of many of the plants of the Newark system with those of the Lettenkohlen I am not able to offer an opinion; but such an exceptional occurrence, it seems to me, should be fully verified before being used as the basis for detailed correlation. If a large number of the plants of the Newark and of the Lettenkohlen are identical, is it necessary to conclude that they were contemporaneous? As already stated, it has been pointed out by Huxley and others that, even if the fossils in widely separated regions are of the same species, it does not follow that they lived at the same time. Their identity indicates a similar position in the geological scale, and nothing more. To go beyond this, and conclude that because of the occurrence of plants in the Richmond area identical with those of the Lunz sandstone the strata above the plant-bearing beds in the former region should be referred to the Keuper, and those below to the Muschelkalk, is to grant certain assumptions the verity of which is more than questionable. One of these assumptions is that sedimentation progressed in the same order in the Virginia region that it did in Central Europe. This implies that elevation and depression of the earth's crust producing changes in sedimentation occurred synchronously in the areas referred to. Such a coincidence is far from probable, and, even if it did occur, is not a logical basis for correlation. Such considerations, and the fact that the Newark after prolonged study has not been subdivided, so as to correspond with any portion of the European standards, point to the absence of a logical basis in the method of correlation indicated in the above quotations, and render it evident that we must be skeptical as to the accuracy of the very definite conclusions there reached.

That the strata of each separate land area should be studied and correlated so far as possible among themselves before attempting anything more than the most general correlation with the strata of other land areas is, in my opinion, well illustrated by the example just cited.

That even the groups found on this continent can not be definitely correlated with those of Europe, has been pointed out especially by White[1] in an essay on "The North American Mesozoic." It is there shown that the Chico-Tejon series of the Pacific coast, containing a well characterized Cretaceous fauna and an equally well characterized Tertiary fauna, has intermediate beds in which there is no stratigraphic break. The same principle is again illustrated in New Mexico, where an unbroken succession exists between Paleozoic and Mesozoic groups. Other instances of similar transitions between groups shown by their fossils to be closely similar to certain great divisions of European rocks, are known in India and New Zealand. These instances illustrate the fallacy of assuming that the life record or the stratigraphic sequence, in any two regions is the same. They show, too, the impossibility of applying an inflexible standard of classification determined from a study of the rocks and fossils of one region to the rocks and fossils of another region. This matter could be still further discussed and illustrated, did it seem advisable, but enough has probably already been said to indicate the weakness of the system criticised. The question, What is the most practicable method of correlating the terranes of widely separated regions, is still a matter for discussion.

PRINCIPLES ON WHICH WIDELY SEPARATED TERRANES MAY BE CORRELATED.

Of the physical and biological phenomena cited in the last few pages, by means of which terranes may be correlated, it is evident that the only infallible method capable of general application is based on the contact of strata. Sedimentation has gone on ever since life existed on the earth, but no universal sheet of sediment has been spread out. On the contrary, continuous sheets of sediments of like kind are frequently restricted to comparatively small areas. This is well illustrated by the manner in which sediments are now being deposited along the Atlantic border of America. These have recently been mapped by Alexander Agassiz from data obtained from soundings, and classed in thirteen divisions, ranging from the sands and clays of the littoral zone to the ooze, and the red clay of the deep ocean, and in each deposit characteristic life forms are being entombed.

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[1] Am. Assoc. Adv. Sci., Proc., vol. XXXVIII, 1889, pp. 205-226.

Moreover, in no region has sedimentation gone on without many changes and many breaks from the dawn of life to the present time, as is abundantly proved by the generally fragmentary condition of the geological series.

These considerations show in a general way, and without taking account of orogenic disturbances, that the sedimentary strata of which the earth's crust is largely composed may be considered as a series of irregular lenticular sheets, some of which are piled in an orderly sequence; others touch only on their edges; others are completely separated and connected by intermediate layers by which their relative age may be determined; others still have no physical connection, and their relative age must be determined by other means. The correlation of these various strata the world over is one of the problems that geologists have before them. What is the most practicable way of accomplishing the task?

In order to arrive at a general scheme of geological correlation for the whole earth it seems evident that each separate land area should be studied by itself and the sedimentary strata composing it arranged, so far as possible, in the order of their age as determined by physical relations.

When correlation by contact and relation to physical phenomena shall have been determined for the terranes over a large part of the separate land areas of the earth, and their corresponding life records determined, the correlation of these various fragmentary histories, with the object of determining the life history of the earth, may be practicable. Evidently the correlation of the strata forming separate land areas can not be made by contact, and it is doubtful if the relation of the strata to widely reaching physical phenomena will ever be valuable for this purpose. The only resource, therefore, is the comparison of life records. The great advances that have been made in paleontology are such as to indicate that when the life records of all the continents shall have been studied independently, and the strata in each correlated by contact, so far as possible, there will result a sufficient body of facts to enable paleontologists and geologists to formulate a somewhat complete history of the progress of life on the earth, showing the special modifications in various regions. Such a standard, when well advanced toward completion, could be used for the determination of the homotaxial relation of the terranes in various regions, and would serve as an important factor in determining what general scheme of classification is most advantageous for showing the approximate correlation of the more important rock series. But not until the relation of the systems composing the various continental land areas shall have been determined, so far as practicable, by contact and the character of their faunas and floras ascertained, can we hope to have a biological time scale by means of which the position of the rock systems forming various continents can be adjusted. Even when this ideal stage is reached it will probably be found that the correlation, even of systems in widely separated regions, will still be general and not specific.

In studying the geology of any region, the primary aim should be to establish the succession of rocks there found by means of their relation to each other and to wide-reaching physical phenomena. At the same time the varied physical events recorded in the rocks should be interpreted and their organic remains carefully studied. The fossils from various natural subdivisions should be preserved separately and submitted to the zoologist and botanist for the determination of their place in the zoological and botanical series. In all cases the relative age of the various faunas and floras should be determined by the relation of the strata containing them, and not the relation of the strata except in a general way and after many fossils have been collected from the contained organic records.

MANNER IN WHICH AMERICAN TERRANES HAVE BEEN CORRELATED.

From the beginning of geological investigation on this continent to the present time, one of the primary and immediate ends that many geologists have had in view was the close correlation of the terranes found here with those occurring in Europe. This correlation has frequently been attempted on the basis of a large number of fossils either specifically or generically identical with those found in Europe. In other cases but few fossils have been obtained, but great weight has been given to these in deciding on the age of the beds in which they occur. In still other instances mere lithological resemblances have been used as a basis for correlation. Again, in many instances, opinions have been expressed as to the position of our terranes in the European scale, and European names adopted in geological treatises and on geological maps, without any statement whatever of the facts on which the correlations were made, or of the principles of correlation which led to a decision. The result is that European names have been fastened especially on the larger divisions of the geological column, without adequate proof that the groups, systems, series, etc., thus designated correspond, except in the most general way, with those bearing similar names across the Atlantic. As the larger divisions in the geological column are supposed to be determined by great unconformities, or by almost complete breaks in the organic records, it is by no means probable that these lines of demarcation coincide in age with the dividing lines in the European standard. Who can say, for instance, that the upper and lower limits of the American Silurian or of the American Devonian corresponds to the upper and lower limits of the divisions bearing these names in Europe. The life histories of these groups undoubtedly coincide in a general way with the life histories of the similar groups in Europe, and in this sense their position is determined. But when the principles of correlation are carried to the smaller divisions in the column, as many geologists and paleobiologists have attempted to do, failure has resulted.

The firm manner in which the European names have been fastened to the American rock series compels their use at present, but always with a mental reservation that they do not strictly coincide with the terranes for which they have been named. As an example, the red beds of the far West and the strata immediately above and below them may be cited. These terranes have been classified as Permian, Triassic and Jurassic, and will have to be spoken of under these titles, although we know that their natural divisions are not the same, and that they can not be correlated except in the most general way, with European systems. It would have been just as logical to have named the strata referred to after terranes bearing somewhat similar fossils in Asia, Africa, or New Zealand as it was to give them the names by which they are now known. It is in fact only after the biological succession in these and other land areas shall have been worked out and compared that anything like a geological history of the earth can be written.

The correlation of the terranes of one with those of another land area is a matter for special consideration, not in the initiative, but in an advanced stage in the study of its geological history.

The adoption of the name "Newark system," proposed by Redfield for the great deposits of sandstone, shale, etc., along the Atlantic border, which form a sharply defined system, limited above and below by great unconformities, is an attempt to break away from the practice of correlating our strata with those of Europe on indefinite evidence and by illogical methods, and is a move toward the establishment of a definite American standard based on a natural system.

In thus venturing to indicate what I consider errors in the method commonly employed in correlation, I do not wish to be understood as attempting to detract in the least from the great importance of the study of the fossil plants and animals. On the contrary, I have the highest admiration for the grand results that have been reached in this direction, and wish to see the work continued. The value of fossils as a practicable means for correlating strata, after their relative age has been determined by superposition, is well established and thoroughly appreciated by every working geologist. It is, perhaps, possible that the life history of the earth is now sufficiently well known to be used at least tentatively in establishing the homotaxial position of terranes in widely separated areas. By applying and correcting the standard from time to time, more precision in the divisions of the scale will result.

CORRELATION OF THE NEWARK SYSTEM.

In the Acadian area the rocks of the Newark system rest unconformably upon the Carboniferous as has been determined by Dawson.[1] In the Connecticut valley the system is underlain unconformably by metamorphosed and crystalline rocks, believed to be in part of lower Silurian age. In the northern part of the New York-Virginia area the rocks beneath the Newark are also crystallized and their age as yet undetermined. In the southern portion of the western border of the system in New Jersey, however, the Newark rocks rest unconformably upon Silurian limestone, as has been determined by the Geological Survey of New Jersey, and a similar relation exists in Pennsylvania. In Maryland the rocks beneath the Newark system are in part Silurian and in part metamorphosed and of indeterminate age. Through all of the Newark areas south of the Potomac, the system rests unconformably upon more or less metamorphosed rocks, the age of which is as yet undecided.

As pointed out by Rogers, the Newark system in Pennsylvania is unaffected by the crumpling and folding impressed upon a large portion of the Appalachian region, and hence is of later date than what is known as the "Appalachian structure." As this structure was produced after the deposition of the Coal-measures, the relation of the Newark system to this crust movement is proof that the system is younger than the Carboniferous. This conclusion, as we have seen, is sustained by the unconformity between the Newark system and Carboniferous rocks beneath in Nova Scotia.

The nature of the unconformity at the base of the Newark system throughout is not only proof that the system is of younger date than the rocks on which it rests, but is evidence that a long period of erosion intervened between the deformation of the underlying beds and the depositions of the superior system.

The next series of rocks deposited in the Atlantic coast region after the Newark is the Potomac. As described by McGee,[2] this formation in Pennsylvania and New Jersey rests in part on the eroded edges of tilted Newark strata and on truncated trap dikes which traverse it. The unconformity between the Newark system and the Cretaceous rocks resting upon it along its eastern border in New Jersey was determined also by the Geological Survey of New Jersey. In Virginia the Taylorsville and Richmond areas are overlain unconformably by the Lafayette.

On the eastern edge of the Deep river and Wadesboro areas in North Carolina, there are sands of Tertiary or more recent date, which rest upon the eroded surfaces of the rocks of the Newark system. The presence of the Potomac formation in this region, resting unconformably upon the Newark, is also suspected, but has not been definitely determined.

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[1] Acadian Geology, 3d ed., London, 1878, pp. 86–113.

[2] Three formations in the middle of the Atlantic slope. In Am. Jour. Sci., 3d ser., vol. xxxv, 1888, pp. 134–136.

The evidence furnished by the formations resting unconformably upon the Newark system is such as to prove that the rocks of that system were upheaved, faulted, diked, and subjected to decay and deep erosion before the oldest of the overlying formations was deposited.

A long interval of land conditions, during which crust movements on a grand scale as well as decay and erosion took place, intervenes both between the Newark system and the rocks on which it rests, and between that system and the rocks which rest upon it.

So far as stratigraphy can be used in determining the age of the system, it proves that it is younger than the Carboniferous rocks of the Atlantic coast region, from which it is separated by a period of erosion, and older than the Potomac formation, from which it is also separated by a period of erosion.

There are no other terranes in the eastern part of the United States. falling in the interval which is shown by stratigraphy to be occupied in part by the Newark system, and there is, therefore, no necessity at this time for discussing the homotaxial relation of that system to neighboring terranes.

RELATION TO TERRANES IN THE WESTERN PART OF THE UNITED STATES.

There are several rock series in the Rocky Mountain region which have been shown by their stratigraphic relations to be intermediate between the Carboniferous and the Cretaceous. These have been referred to the Permian, Triassic, and Jurassic of Europe, on account of their stratigraphical position and the nature of the fossils which they contain. The accuracy of this correlation or the character of the evidence on which it rests, it is not necessary to discuss at this time. There is no physical connection between the Newark system and the terranes just referred to, by means of which their relative age can be determined. Only a few fossils have been found common to the two systems, and hence there is no adequate basis for close correlation.

A few plants collected by Newberry[1] at Abiquiu, New Mexico, were determined by him to be specifically identical with fossil plants found in the Newark system in Virginia and North Carolina. From this evidence it is believed by Newberry that the plant-bearing beds in the two areas referred to are of about the same age, and correspond with the upper Triassic of Europe. The similarity in age between the Newark system and the terrane at Abiquiu, New Mexico, is indicated also by specific identity of the silicified wood found in the two regions, as has recently been determined by Knowlton.[2]

A few fossil bones obtained by Cope, from the so-called Triassic rocks of New Mexico, have been determined by him to be closely allied to the reptilian remains of the Newark system, and in each case are referred to the upper Trias of Europe.

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[1] U. S. Geol. Surv., Monograph vol. XIV, pp. 14-15. See also by the same author, Report of the Exploring expedition from Santa Fé, N. Mex., to the junction of the Grand and Green rivers of the great Colorado of the West, in 1859, under the command of J. N. Macomb. Washington, 1876, pp. 141-148, pls. 4-8.

[2] Ante, p. 29.

The rich reptilian and mammalian fossils discovered by Marsh at Como (Aurora), Wyoming, near Canyon City, Colorado, and at other points in the Rocky Mountain region, from so-called Jurassic rocks, are considered by their discoverer to be of younger date than the Newark system.

Other vertebrate fossils collected in the so-called Permian of the far West are considered by Cope to be of older date than the Newark.

So far as indicated by organic remains, therefore, the Newark system may be considered as occupying a place in the geological column similar to that occupied by the Triassic rocks or Red beds of the Rocky mountain region. That this correlation is extremely indefinite is shown by the fact that in the Rocky mountain region the rocks referred to the Permian, Triassic, and Jurassic belong to a natural system, in which there are no great unconformities and no persistent features by means of which they may be divided at various localities. Had they been studied in connection with the geology of the region in which they occur, independent of any preconceived notions of European correlation, there is no question that the lines of division would have been drawn differently than at present. The scarcity of fossils in that portion of the western system which coincides most nearly with the Newark system is such that a definite correlation with other similar faunas and floras at a distance must be accepted as provisional even by the most sanguine of those who believe in a detailed correlation of strata by means of fossil remains. The uncertainties arising from this cause are still further increased by the fact that the attempts which have been made to correlate the Newark system with the Triassic of the Rocky mountains, depend in large part upon the relation of the fossils of each of these systems to the Triassic fossils of Europe. It seems wise to conclude, therefore, that only a very general relation between the Newark system and the so-called Triassic rocks of the Rocky mountain region has been established, and to wait for further evidence before deciding that a close correlation is practicable.[1]

RELATION TO EUROPEAN TERRANES.

No other system in America has been the subject of so much discussion respecting its position in the European standard of classification as the one now under review.

I have made abstracts of such determinations and opinions of the age of this system as are based on paleontological evidence, not including those in which mere opinions have been expressed without stating the basis on which they are founded. The number of these abstracts is over eighty.

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[1] Since this paper was written L. F. Ward, from a comparison of the fossil plants of the Newark and of the Trias of the Rocky mountain region, has reached the following conclusion: "As regards the western deposits, notwithstanding the poverty of their present known flora, there seems to be some indication that they were not laid down at the same exact epoch as those of the Atlantic coast; but, assuming such an asynchronism, the question as to whether they are earlier or later can not be profitably considered with the present insufficient data." Bull. Geol. Soc. Am., vol. XXIII, 1891, p. 28.

Rejecting certain early correlations which referred the Newark system to Silurian, Carboniferous, and Devonian groups, which need not be discussed at this stage of geological study, the remainder of the determinations referred to, and especially the more recent ones, correlate the rocks in question, either wholly or in part, with the Triassic or the Jurassic systems of Europe. Without attempting to give the chronological history of the discussions and controversies that have arisen on this subject, and which are still being pressed in certain quarters, I shall try to indicate, so far as practicable, the nature of the evidence that has been obtained and the conclusions which have been derived from it.[1] The reader will then, at least to some extent, be in a position to judge for himself as to what is the safest position to maintain in reference to the age of the system we are studying.

Fossils of the Newark system, as has already been stated, consist of obscure molluscan remains, larvæ of insects, cases of minute crustaceans, fragmentary portions of the skeletons of mammals, batrachians, and reptiles, fossil fishes, footprints, and plant remains. Owing to the great rarity and to the obscurity of molluscan and insect fossils, the only organic record at present available as a means of correlation are vertebrates, crustaceans, and plants.

TESTIMONY OF THE VERTEBRATES.

Mammals.—The remains of small mammals were discovered by Emmons in the Newark rocks of North Carolina and referred by him to the Permian, on account, principally, of the reptilian fossils associated with them.[2] These remains were studied also by Leidy, who stated that they find very close representatives in the Purbeck beds of the Oolitic of England.[3] The fossil mammalian jaws described by Emmons have recently been reexamined by Osborn, who concludes that they are widely aberrant forms, and not closely related to any fossils hitherto discovered.[4] The investigations by O. C. Marsh in the Jurassic system of the Rocky mountain region have brought to light a large number of small mammalian fossils having a resemblance to the remains found in the Newark system, but these, as stated by their discoverer, are generally distinct.[5]

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[1] Some account of the various determinations of the age of the Newark that have been made is given by—

Lea, Isaac: Description of a fossil saurian of the New Red Sandstone formation of Pennsylvania, with some account of the formation. In Philadelphia Acad. Nat. Sci. Jour., 2d ser., vol. II, 1850–1854, pp. 185–189.

Newberry, J. S.: Fossil fishes and fossil plants of the Triassic rocks of New Jersey and the Connecticut valley. U. S. Geol. Surv., Mon. vol. XIV, Washington, 1888, pp. 8–15.

Marcou, J.: The Triassic flora of Richmond, Virginia, Am. Geol., vol V, 1890, pp. 160–174.

[2] American Geology, part 6, Albany, 1857, pp. 95–96.

[3] Philadelphia Acad. Nat. Sci., Proc., vol. IX, p. 150.

[4] Philadelphia Acad. Nat. Sci., Proc., vol. XXXIX, 1887, p. 291.

[5] Am. Jour. Sci. 3d ser., vol. XXXIII, p. 344.

The small number of mammalian remains thus far obtained from the Newark system, and the limited knowledge possessed at the present time of the early forms of mammalian life, renders it evident that they can not be used, except in a most general way, in determining the age of the strata in which they occur.

Batrachians and reptiles.—Fragmentary portions of the skeletons of large animals were discovered by E. Emmons in his early explorations of the Newark rocks of North Carolina, and determined by him and by Leidy to be most nearly related to the Permian vertebrates of the Old World. These same fossils were studied also by Isaac Lea in connection with similar remains from Pennsylvania, and considered to agree most nearly with similar remains found in the Triassic rocks of Europe.[1]

The fossils studied by Emmons, Leidy, and Lea have since been reexamined and their classification revised by Cope, who finds that certain of the genera found in the Newark rocks occur also in the Triassic rocks of New Mexico. After describing the vertebrate fossils of the New Mexico deposits, this author states that there is a close parallelism between them and the similar fossils from the upper Keuper of Wurtemberg. To quote the author's words:[2] "In both regions the genera Belodon and Tanystrophaeus are abundant and the Artosaurus of the former [Wurtemberg] is represented by the Tylothoras of the latter [New Mexico]. The association of such very diverse forms is good evidence of general identity of fauna, and is a sufficient basis for asserting taxonomic identity of the forms of the two regions."

Again, after studying the vertebrate fossils of the Newark rocks of Pennsylvania, Cope observes:[3] "Geologists have been inclined to identify these beds with the Upper Trias and the Lower Jurassic. The identification of the Belodon and Mastodonsaurus points most strongly to the age being that of the Keuper or upper divisions of the Trias."

The testimony of the fossil footprints so abundant in certain portions of the Newark system is less definite than that derived from the bones and teeth found in the same rocks and probably belonging in part to the same species. No fossil footprints found in other countries have a sufficiently close relation to those of the Newark system to be indentified with them, and, therefore, no close correlation can be based upon these interesting records of a vanished host. Paleontologists would probably agree if no other fossils than footprints were known from the Newark system, that the only admissable conclusion as to their age would be that they are probably somewhat younger than the Carboniferous.

The evidence from vertebrate remains evidently indicates that the position of the Newark beds in the geologic series coincides in a general way with that of the Upper Trias of Europe and with the horizon of the so-called Triassic beds of the Rocky mountain region.

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[1] Philadelphia Acad. Nat. Sci., Proc., vol. x, p. 92.

[2] Am. Phil. Soc. Proc., vol. xxiv, 1887, p. 227.

[3] Philadelphia Acad. Nat. Sci., Proc., vol. xviii, 1866, p. 250.

Fishes.—The fossil fishes of the Newark system have been studied, especially by J. H. Redfield and W. C. Redfield, Agassiz, Edgerton, and Newberry. The conclusion reached by the Redfields,[1] father and son, was that the rocks could not be older than the Trias, but must be placed as low as the Lias and Oolite. Agassiz, on examining the fossil fishes of the Richmond area, suggested from their analogy with European forms, that they were of the age of the Lias.[2] Later, in discussing a paper on the Coal-bearing rocks of Virginia and North Carolina, by Johnson, he observes that the fossil fishes of the Richmond area and from "the so-called New Red Sandstone, indicate an age intermediate between the European New Red and the Oolite."[3] Still later he states that the fossils referred to do not agree either with the fossil fishes of the Trias of Southern Germany or with those of the Lias of England, but seem intermediate between the two, and is inclined to refer the Newark system to a group intermediate between the Trias and the Lias for which there is no equivalent in Europe.[4]

By far the most important contribution to our knowledge of the fossil fishes of the Newark system have been made by Newberry. His opinion with reference to the age of the system, based principally on fossil plants, is that it represents only the uppermost portion of the Triassic, and is the equivalent of the Rhetic beds of Germany. In reference to the bearing of the fossil fishes on the question of age, he says:[5] "The fishes so abundant in our Trias [Newark]—*Ischypterus* and *Catopterus*—have never been found in the Old World, and therefore throw no light on the question. But their affinities are more with the Mesozoic fishes (Jurassic and Cretaceous) than with *Palæoniscus*, etc., of the Permian. Much rarer fishes have recently been obtained by the speaker from the Connecticut Trias—*Dipleurus* and *Ptycholopis*—which, though new, represent groups confined to the Jura of the Old World."

The question of the geological equivalents of the Newark system is discussed at length in Newberry's recent monograph on the fossil fishes and fossil plants of the Newark system, but the value of fossil fishes as a basis of correlation is not specifically considered. The final conclusion in reference to correlation expressed in the volume mentioned is the same as previously stated, and places the Newark system on a parallel with the Rhetic of the Old World.[6]

TESTIMONY OF THE CRUSTACEANS.

The minute fossil crustaceans of the Newark system were studied to some extent by Emmons, Rogers, and others, and certain conclusions in reference to geological age based on them. The results reached by these authors were subsequently reviewed by T. Rupert Jones, with the aid of abundant specimens.[1] In summing up the evidence furnished by the crustaceans, this author says: "Whether or not these deposits have a Keuperian character, as Prof. O. Heer's late determinations of the Coal plants from Richmond, Virginia, seem to indicate, there is no doubt of their being the products of lagoons in the Lower Mesozoic period, and contemporary either with the marine formation intermediate to the Trias and Lias, namely, the Rhetic, or with the Upper Trias itself, and exactly equivalent to the Lettenkohle (carbonaceous shales at the base of the Keuper.)"[2]

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[1] Am. Assoc. Adv. Sci., Proc., vol. IX, 1856, p. 185.

[2] Geol. Soc., London, Quart. Jour., vol. III, 1847, p. 275

[3] Am. Assoc. Adv. Sci., Proc., vol. IV., 1850, p. 276.

[4] Am. Acad. Proc., vol. III, 1852–1857, p. 69.

[5] New York Acad. Sci. Trans., vol. V, 1885–'86, p. 18.

[6] U. S. Geol. Surv., Mon. vol. XIV, Washington, 1888, pp. 8–15.

The evidence furnished by the crustaceans, minute as they are, must evidently be considered as important and as sustaining the more recent conclusions reached from a study of the reptilian remains.

TESTIMONY OF THE PLANTS.

The resemblance of some fossil plants of the Richmond area to those of the Keuper of Central Europe led Marcou[3] to assign them to the same horizon as early as 1849.

The plants, like the reptilian remains, were studied at an early date by Emmons, who concluded from this and other evidence that the upper part of the Newark system in North Carolina represented the Keuper. This conclusion was based largely, however, on the opinion of Heer, who, from a study of a small collection of fossil plants, concluded that "Certain forms found in North Carolina are characteristic of the Keuper and Marnes Irisées of Germany, France, and Switzerland; and certain other forms are closely related to the species found in Europe in the Keuper and Lower Lias, but are all different specifically; but there are none which are really Oolitic either in Virginia or North Carolina."[4]

Rogers, in 1858, after reviewing all the available evidence as to the geological position of the Newark system, reached the following conclusion:[5]

> These strata are placed in parallelism with the Lower Mesozoic formation of Europe—the Upper Triassic and the Lower Jurassic rocks—not merely through the few European species which they possess, but quite as obviously by the general aspect or *facies* of nearly all the organic remains which they have hitherto disclosed. Every year is adding to this list, and, as they multiply, the impression produced leans more and more toward the conviction that they were created in a period which unites the Triassic and Jurassic ages.

Rogers, in an essay on the age of the Newark system, after a comprehensive review of all the evidence furnished by fossil plants at that time available, concludes that these fossil remains as a group bear a remarkable resemblance to those of the Oolitic rocks of Europe. Some of the species are stated to be specifically identical with European forms, while others are very closely allied to certain species found in the Oolitic of the Old World (p. 299). In conclusion, Rogers states that he has no hesitation in referring the coal of eastern Virginia to a place in the Oolitic system on the same general parallel, and with the carbonaceous beds of Whitby and Brora, that is, in the lower part of the Oolite group[1] (p. 300).

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[1] A Monograph on the Fossil Estheria. Paleontological Soc., London, 1862.
[2] Ibid, p. 126.
[3] The Triassic flora of Richmond, Virginia., Am. Geol., vol. v, 1890, pp. 163.
[4] Am. Assoc. Adv. Sci., Proc. vol. xi, 1858, p. 79.
[5] Geol. of Pennsylvania, 4to, Philadelphia, 1858, vol. ii, p. 697.

A few vegetable remains found in the Newark rocks of the Connecticut valley were figured and described by Hitchcock, and considered by him to indicate a parallelism with the Jurassic of Europe. These remains were so imperfect, however, and so little was then known concerning the fossil floras of the systems with which they were considered to be most nearly related, that but little weight can be attached to this examination.[2]

Fossil plants collected in the Richmond field by Lyell were studied by Bunbury whose final conclusions in reference to their age, as stated by Lyell,[3] placed them on a parallel with the Keuper.

By far the most important contributions made to our knowledge of the fossil flora of the Newark system, is contained in a monograph by Fontaine.[4] As stated by this author there are 42 species of plants from the Richmond area sufficiently well preserved to be of some value in determining the age of the beds. Of these 21 appear to have no near relation in the European floras, but their general character points strongly to a Rhetic or Jurassic age. Three identical and 5 allied species, or 19 per cent, find their representatives in the Jurassic formation. The Jurassic element is much stronger than the Triassic, even without counting the plants of Jurassic generic type found in the species peculiar to Virginia (p. 95). There are 4 species identical with Rhetic forms, and 8 allied to them, or 28 per cent. The Rhetic can, then, claim the largest percentage of identical and allied species. Among them are some of the most abundant and characteristic forms of the Virginian flora. The great abundance and wide diffusion of the *Macrotaeneoptereis magnifolia*, and *Ctenophyllum braunianum* give these plants great weight.

Fontaine's conclusion from the facts briefly indicated above is that we must consider this flora as not older than the Rhetic, the only question being whether its strong Jurassic evidence ought to cause us to regard it as at least Lower Jurassic in age (p. 96).

In the same monograph there is contained a review of the fossil plants of the Newark rocks of North Carolina, described by Emmons, in which 49 species are identified. Of these, 9 are stated to be peculiar to North Carolina, and have no very near allies in other countries. Fifteen species are found in the Newark rocks of Virginia. Assuming, as stated by the author, that the Rajmaahal group, India, is of Liassic age, there are 2 species identical with, and 6 nearly allied to Jurassic plants. Seven species are identical and 8 closely allied to Rhetic plants. Twenty-three per cent are peculiar to North Carolina, while 41 per cent are found in the Newark rocks of Virginia; 20 per cent are allied to or identical with Jurassic forms. Thirty per cent are identical with or allied to Rhetic species. After studying the fossil plants of both Virginia and North Carolina, Fontaine's final conclusion is that these floras are probably of the age of the Rhetic. In his own words: "We are, then, I think, entitled to consider that the older Mesozoic flora of North Carolina and Virginia is most probably Rhetic in age and certainly not older."

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[1] On the age of the coal rock of eastern Virginia. In Assoc. Am. Geologists and Naturalists, Trans., 1840-1842, pp. 299-300.

[2] Ichnology of New England, Boston, 1858, pp. 5, 6, 7.

[3] Elements of Geology, 6th ed., 1886, p. 452.

[4] U. S. Geol. Surv., Mon. vol. VI, Washington, 1883, pp. 92-96, 121-128.

"Some authors hold that the Rhetic beds form the uppermost of the Triassic strata. Others think that they are transition beds having affinity with the Lower Lias. The latter view will, I think, be justified by a study of the flora, and I have, in this memoir, assumed its correctness" (p. 128).

Newberry, in his monograph on the fossil fishes and fossil plants of the Newark system already referred to, concurs with Fontaine in referring the flora of the system to the Rhetic (p. 13). He also says that several species of plants common in the Newark system are found at Abiquiu, New Mexico, and at Sonora, Mexico. The author states that this "indicated a parallelism between the plant-bearing beds of the Atlantic Trias [Newark] and those of New Mexico and Sonora, and go far to prove that all of our Triassic rocks which have yet yielded plants belong to the uppermost division of the system" (pp. 14–15).

Stur,[1] in a review of Fontaine's monograph on the flora of the older Mesozoic of Virginia, has identified a large number of the plants from the Richmond area with those of the Lunz sandstone of Germany, and concludes that the plant-bearing beds of the Newark are the equivalent of the Lettenkohle group of Germany. The great confidence that this author gives to his determinations is indicated in the quotations given in this paper on pp. 114–115.

B. Zeiller[2] has also reviewed Fontaine's monograph, and identified certain of the plants there described with those of the grès bigarré of Europe. This identification of species and also the absence in the Newark system of certain types that had an immense distribution during the Rhetian epoch, and as stated by Zeiller, have been found in nearly all the Rhetian deposits of Europe lead to a final conclusion in reference to correlation, which is stated as follows:

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[1] Die Lunzer (Lettenkohlen) Flora in den "older Mesozoic beds of the coal-field of eastern Virginia." In Separatabdruck der Verhandlungen der k. k. geologischen Reichsanstalt No. 10, 1888, pp. 203–217.

[2] Sur la présence, dans le grès bigarré des Vosges, de l'Acrostichides rhombifolius, Fontaine. In Société géologique de France, Bull., 3e série, t. XVI, p. 693–698, séance 18 Juin, 1888.

> Thus, without pretending, at so great a distance, to make a formal correlation, I think that one may, with great plausibility, arrange the coal-bearing strata of Virginia and North Carolina, with the Upper Trias, as was done by O. Heer, and to place them parallel with those of Bâle (Neue Welt), Stuttgart and Lunz; that is to say, at a level little different, on the whole, from that assigned to them by Mr. Fontaine, but yet a little higher (p. 698).

The evidence furnished by the fossil plants, while not interpreted in the same way by various paleobotanists, points on the whole to a somewhat higher division in the time scale of Europe than the vertebrate and invertebrate fossils.

Before closing the review it will be well to consider what may be classed as negative evidence. This is furnished by the remarks of Dana, made more than thirty years ago, in connection with a review of Emmons geological report of the Midland counties of North Carolina. He says:[1]

> In the determination of the exact age of this sandstone, the only rock in this country east of the Mississippi occurring between the Carboniferous and the Cretaceous, we can not be too cautious in the use of evidence. One or two considerations are, therefore, here suggested. In the first place the fauna and flora of America of this modern epoch is represented in Europe, and quite strikingly, as has been shown by the fauna and flora of the later Tertiary of Europe. The life of corresponding ages in the two continents has thus been older in America than in Europe. This is one point to be well weighed. Again, in determining the age of a rock from its fossils, we should rather look to those which indicate the more recent period than those which bear the other way. This criterion would bring us right with regard to our own epoch, while by avoiding it we might be able to prove that we in America are of the Tertiary age of the world. Now, as Mr. Redfield has shown, the fossil fishes—the most characteristic species of any formation—are but *half* heterocercal and come nearer to the Jurassic type than the Triassic. There is hence reason for the opinion, notwithstanding the important evidence brought forward by Dr. Emmons, that the Lias period may be represented by the formation; and we may be nearest the truth if we regard the whole formation as corresponding to the Lias and the latter half to the Trias. The examinations by Mr. Heer accord with this conclusion. The European subdivisions of the Trias we should not look for on this continent, even if we had the whole of the formation, any more than the European subdivisions of the Devonian in the American Devonian. American geology is deeply interested in the decision of this question, and owes much to Prof. Emmons for all that he has done toward its elucidation.

SUMMARY.

The conclusions reached, as indicated above, by those best qualified to determine the nearest equivalents of the Newark system in the geological series of Europe, present some diversity.

The Batrachians and reptiles as shown by the most recent and most extended studies, that have been made, have their nearest known representatives in the Keuper of Germany.

The fossil fishes are not nearly related to those of any formation in Europe, but represent groups confined, so far as is now known, to the Jurassic.

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[1] Am. Jour. Sci., 2d ser., vol. XXIX, 1857, pp. 429-430.

The crustaceans have their nearest representatives in the upper Trias or in the Rhetic.

The plants have been assigned to various horizons, but the most recent and probably the most reliable determinations, place them in the upper part of the Triassic or in the Rhetic; Heer, Stur, and Zeiller claiming them as belonging to the Keuper, while Fontaine and Newberry consider that they more nearly represent the flora of the Rhetic.[1]

This brief résumé of what must be considered the most trustworthy correlations now possible, shows that there is a closer accord in the various determinations than, perhaps, might have been supposed. The geologist who has to depend on the paleontologist for the correlation of strata in widely separated regions, is thus furnished with all the data available on which to base his conclusions. It is probable that the evidence, as it now stands, when considered by various persons, will be interpreted in two ways.

Those who are inclined to believe that a close correlation is possible between the divisions of the geological column in America and Europe, will probably demand further evidence and will continue the controversy as to the equivalency of particular horizons in the two countries.

Those who take the ground that the large natural division of the rock series in America and in Europe admit of correlation only in a broad, general way, will conclude that the correspondence reached from the comparisons already made are sufficient to show that the fossil-bearing strata of the Newark system may be placed in general parallelism with the upper part of the Triassic and the lower part of the Jurassic of Europe. As a system, however, it can not be considered as the equivalent of any definite portion of the European scale.

When the geological succession in the other portions of the earth shall have been determined, and the existing blanks in our knowledge of the succession of organic forms filled, at least in part, it may be possible to form a more comprehensive scheme of classification than any now known, in which the relative position of the strata in various widely separated localities may be some time definitely determined. Until such a standard of comparison approaches completion, we must conclude that the Newark system is a well defined unit in American geology, having a great unconformity both above and below, and that it belongs in the lower portion of the Mesozoic group of the American geological column. The Mesozoic itself, however, does not agree either as to its upper or lower limits with the Mesozoic of Europe, but represents, as nearly as can be determined from our present knowledge of its organic remains, about the same relative position in the life history of the earth.

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[1] The most recent review of the relation of the fossil plants of the Newark to the Triassic flora of Europe which has come to hand is by L. F. Ward (Bull. Geol. Soc. Am., vol. III, 1891, pp. 23–31). The conclusion reached is that our present knowledge fixes the horizon of the Newark "with almost absolute certainty at the summit of the Triassic system, and narrows the discussion down chiefly to the mere verbal question whether it shall be called Rhetic or Keuper. * * * The beds that seem to be most nearly identical, so far as the plants are concerned, are those of Lunz, in Austria, and of Neue Welt, near Basle, in Switzerland. These have been placed by the best European geologists in the Upper Keuper. Our American Trias [Newark] can scarcely be lower than this, and it probably can not be higher than the Rhetic beds of Bavaria."

RELATION TO TERRANES OF ASIA AND CENTRAL AMERICA.

Direct comparisons have been made by Newberry between the fossil plants of the Newark system and similar fossils from China and from Honduras.

A comparison with fossil plants from China collected by Pumpelly in the Kwei basin on the Yangtse river, province of Hupeh, showed that one species is common to the two regions. Another species found in the Kwei basin agreed closely with a European Jurassic species. Another has a remarkable likeness to a fern which occurs both in the Liassic and Oolitic floras of Europe. The Kwei fossils were also compared with fossil plants from Abiquiu, New Mexico, and Sonora, Mexico, regarded by Newberry as Triassic. The conclusion reached from this study was that the plant-bearing beds of the Kwei basin were of Mesozoic age, but whether they should be considered as Triassic or Jurassic remained undecided. Only a very general conclusion as to the relation of the Newark system to the plant-bearing beds of the Kwei basin, is shown by fossils now known, but it is evident that interesting results might be expected from a continuation of the comparisons of the fossil floras of the two regions.[1]

A collection of fossil plants from San Juancito, Honduras, has recently been described by Newberry and shown to be related to the Rhetic of Europe. This collection contains at least one species that is very close to a plant described by Emmons from the Newark rocks of North Carolina. Others are closely related to the plants of Abiquiu, New Mexico, and Sonora, Mexico. After describing the Honduras fossils, Newberry refers to their relation to other floras in the following language:

"This discovery of a Triassic flora in Honduras is a matter of special interest, as nothing of the kind had before been met with in that section of the globe; but it is only another illustration of the uniformity of the vegetation of the world during the Triassic age. This uniformity was, however, only a development of the systematic progress of plant life. The reign of Acrogens ended with the Permian. The Rhetic epoch was, therefore, about the middle of the reign of Gymnosperms. No Angiosperms were yet in existence, for they began in the Cretaceous. * * *

"Where the Gymnospermous flora originated, or how it was developed from the Acrogens, if it was so developed, and through the exercise of what elements of superiority it superseded them, we are yet in ignorance. It is, however, a matter that may well excite our wonder that, migrating such immense distances from their place of origin, through every phase of soil and climate—through all the zones of the Eastern Hemisphere, and now, as we learn from this group of Honduras plants, through the New World—they march, holding so firmly to their original group of characters, generic and specific, that wherever we open their tombs we recognize them instantly as old friends. In their long marches some perish by the way, and here and there, their numbers were recruited by new forms, imported or developed; but the leading members of the troop in virtue of some occult protection against outside influences, preserved almost without alteration all the complicated characters of their vegetative and reproductive systems.

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[1] Appendix No. 1 to geological researches in China, Mongolia, and Japan [etc.] by Raphael Pumpelly. Smithsonian Contributions to Knowledge, vol. VII, Washington, 1867, pp. 119–123.

"We shall look now with eagerness to South America for the full identification there of this Mesozoic flora, which we have found in full development in Virginia, New Mexico, Sonora and now in Honduras. It had before been recognized in Australia—where it seems to emerge from the Paleozoic flora and perhaps began—New Zealand, India, Tonquin, China, Turkestan and various parts of Europe." [1]

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[1] Rhetic plants from Honduras. In Am. Jour. Sci., 3d ser., vol. XXXVI, 1888, pp. 342–351.

INDEX TO THE LITERATURE OF THE NEWARK SYSTEM.

SOURCES OF INFORMATION.

In compiling this index the principal sources of information have been the national and state geological reports included in Frederick Prime's catalogue of official reports,[1] and all similar reports, published since the appearance of the second supplement of that catalogue, on the subjects referred to in this list. Included with these reports, and mentioned in part in Prime's catalogue, are the publications of the Smithsonian Institution, the U. S. National Museum, the U. S. Coast and Geodetic Survey, the U. S. Department of Agriculture, and handbooks of information published by various states. In addition all books and papers published unofficially, containing information relating to the Newark system, have been examined.

Besides these, the following serial publications have been examined:

CATALOGUE OF SERIAL PUBLICATIONS EXAMINED.

Name.	Published at—	Abbreviation.	Examined.
Albany Institute, Proceedings	Albany, N. Y	Albany Inst., Proc	Vols. 1-12.
Albany Institute, Transactions	Albany, N. Y	Albany Inst., Trans	Vols. 1-10.
American Academy of Arts and Sciences, Memoirs.	Cambridge and Boston, Mass.	Am. Acad., Mem	1st series: Vols. 1-5; 2d series: Vols. 1-15.
American Academy of Arts and Sciences, Proceedings.	Boston and Cambridge, Mass.	Am. Acad., Proc	1st series: Vols. 1-5; 2d series: Vols. 1-15.
American Association for the Advancement of Science, Proceedings.	Salem, Mass	Am. Assoc. Adv. Sci., Proc.	Vols. 1-37.
American Association of Geologists and Naturalists, Proceedings.	Boston, Mass	Am. Assoc. Geol. and Nat., Proc.	Meetings 1-6.
American Association of Geologists and Naturalists, Transactions.	Boston, Mass	Am. Assoc. Geol. and Nat., Trans.	Vol. 1 (1840-1842.)
American Chemical Journal	Baltimore, Md	Am. Chem. Jour	Vols. 1-9.
American Chemist	New York, N. Y	Am. Chem	Vols. 1-7.
American Geologist	Minneapolis, Minn	Am. Geol	Vols. 1-6.
American Institute of Mining Engineers, Transactions.	Easton, Philadelphia, Pa., and New York, N. Y.	Am. Inst. Mining Eng., Trans.	Vols. 1-17.
American Journal of Conchology	Philadelphia, Pa	Am. Jour. Conch	Vols. 1-7.
American (Monthly) Journal of Geology and Mineralogy (Featherstonhaugh).	Philadelphia, Pa	Am. Jour. Geol. and Min.	Vol. 1, Nos. 1-10.
American Journal of Science	New Haven, Conn	Am. Jour. Sci	1st series: Vols. 1-50; 2d series: Vols. 1-50; 3d series: Vols. 1-40.
American Mineralogical Journal (Bruce).	New York, N. Y	Am. Min. Jour. (Bruce).	Vol. 1.
American Museum of Natural History, Bulletin.	New York, N. Y	Am. Mus. Nat. Hist., Bull.	Vol. 1, 2.

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[1] Am. Inst. Min. Eng.. Trans., vol. VII, pp. 455-525. First supplement, vol. VIII, pp. 466-478. Second supplement, vol. IX, pp. 621-632.

Catalogue of serial publications examined—Continued.

Name.	Published at—	Abbreviation.	Examined.
American Naturalist	Salem, Mass., and Philadelphia, Pa.	Am. Nat	Vols. 1-24.
American Philosophical Society, Proceedings.	Philadelphia, Pa	Am. Philo. Soc., Proc.	Vols. 1-26.
American Philosophical Society, Transactions.	Philadelphia, Pa	Am. Philo. Soc., Trans.	1st series: Vols 1-6; 2d series: Vols. 1-16.
Annals of Science (Cleveland)	Cleveland, Ohio	Ann. Sci. (Cleveland)	Vols. 1, 2.
Annual of Scientific Discovery	Boston, Mass	Ann. Sci. Discov	1850-1871.
Appalachia	Boston, Mass	Appalachia	Vols. 1-5.
British Association for the Advancement of Science, Report.	London, England	British Assoc. Adv. Sci., Rep.	Vols. 1-59.
Boston Journal of Natural History	Boston, Mass	Boston Jour. Nat. Hist.	Vols. 1-7.
Boston Society of Natural History, Anniversary Memoirs.	Boston, Mass	Boston Soc. Nat. Hist., Ann. Mem.	1880.
Boston Society of Natural History, Bulletin.	Boston, Mass	Boston Soc. Nat. Hist., Bull.	Vols. 1-4.
Boston Society of Natural History, Memoirs.	Boston, Mass	Boston Soc. Nat. Hist., Mem.	Vols. 1-4.
Boston Society of Natural History. Occasional Papers.	Boston, Mass	Boston Soc. Nat. Hist., Occasional Papers.	Vols. 1-3.
Boston Society of Natural History, Proceedings.	Boston, Mass	Boston Soc. Nat. Hist., Proc.	Vols. 1-24.
Brookville Society of Natural History, Bulletins.	Richmond, Ind	Brookville Soc. Nat. Hist., Bull.	Nos. 1, 2.
Buffalo Society of Natural History, Bulletins.	Buffalo, N. Y	Buffalo Soc. Nat. Hist., Bull.	Vols. 1-5.
California Academy of Sciences, Bulletins.	San Francisco, Cal	California Acad. Sci., Bull.	Vols. 1, 2, Nos. 5-8.
California Academy of Sciences, Memoirs.	San Francisco, Cal	California Acad. Sci., Mem.	Vol. 1, parts 1, 2.
California Academy of Sciences, Proceedings.	San Francisco, Cal	California Acad. Sci., Proc.	Vols. 1-7; second series: Vols. 1, 2.
Canadian Institute, Proceedings	Toronto, Canada	Canadian Inst., Proc.	Vols. 1-5.
Canadian Journal of Industry, Science and Art.	Toronto, Canada	Canadian Jour. Ind., Sci. and Art.	Vols. 1-3; new series: Vols. 1-15.
Canadian Naturalist	Montreal, Canada	Canadian Nat.	Vols. 1-8; new series: Vols. 1-10.
Canadian Record of Science	Montreal, Canada	Canadian Rec. Sci	Vols. 1-4.
Canada, Royal Society, Transactions and Proceedings.	Montreal, Canada	Canada, Roy. Soc., Trans. and Proc.	Vols. 1-4.
Central Ohio Scientific Association, Proceedings.	Urbana, Ohio	Central Ohio Sci. Assoc., Proc.	Vol. 1, parts 1, 2.
Chicago Academy of Sciences, Bulletin.	Chicago, Ill	Chicago Acad. Sci., Bull.	Vol. 1, No. 6.
Chicago Academy of Sciences, Proceedings.	Chicago, Ill	Chicago Acad. Sci., Proc.	Vol. 1.
Chicago Academy of Sciences, Transactions.	Chicago, Ill	Chicago Acad. Sci., Trans.	Vol. 1.
Cincinnati Society of Natural History, Journal.	Cincinnati, Ohio	Cincinnati Soc. Nat. Hist., Jour.	Vols. 1-10; Vol. 12, Nos. 1-3.
Cleveland Academy of Sciences, Proceedings.	Cleveland, Ohio	Cleveland Acad. Sci., Proc.	1845-1859.
Colorado Scientific Society, Proceedings.	Denver, Colo	Colorado Sci. Soc., Proc.	Vols. 1, 2.
Colorado State School of Mines, Reports.	Golden, Colo	Colorado State School of Mines, Rep.	1885-1887.
Columbia College (*see* School of Mines).			
Connecticut Academy of Sciences, Memoirs.	New Haven, Conn	Connecticut Acad. Sci., Mem.	Vol. 1, part 1.
Connecticut Academy of Sciences, Transactions.	New Haven, Conn	Connecticut Acad. Sci., Trans.	Vols. 1-7.
Cornell University, Scientific Bulletin	Ithaca, N. Y	Cornell Univ., Bull	Vols. 1, 2.
Cornwall Royal Geological Society, Transactions.	Cornwall, England	Cornwall Roy. Geol. Soc., Trans.	Vols. 7-9.
Dakota School of Mines, Report	Rapid City, Dak	Dakota Sch. Min., Rep.	1888.
Davenport Academy of Natural Sciences, Proceedings.	Davenport, Iowa	Davenport Acad. Nat. Sci., Proc.	Vols. 1-4.
Denison University Scientific Laboratory, Bulletin.	Granville, Ill	Denison Univ., Bull	Vols. 1-3.
Des Moines Academy of Sciences, Bulletin.	Des Moines, Iowa	Des Moines Acad. Sci. Bull.	Vol. 1. No. 1.
Dublin Geological Society, Journal	Dublin, Ireland	Dublin Geol. Soc., Jour.	Vols. 1-10.
Dublin Quarterly Journal of Science.	Dublin, Ireland	Dublin Quart. Jour. Sci.	Vols. 1-6.
Edinburgh Geological Society, Transactions.	Edinburgh, Scotland	Edinburgh Geol. Soc., Trans.	Vols. 1-4.

Catalogue of serial publications examined—Continued.

Name.	Published at—	Abbreviation.	Examined.
Edinburgh (The) New Philosopical Journal.	Edinburgh, Scotland	Edinburgh New Phil. Jour.	New series, 1-4, 6, 8-19.
Elisha Mitchell Scientific Society, Journal.	Raleigh, N. C	Elisha Mitchell Sci. Jour.	1883-1889.
Elliott Society of Natural History, Journal.	Charleston, S. C	Elliott Soc.Nat.Hist., Jour.	Vol. 1.
Elliott Society of Natural History, Proceedings.	Charleston, S. C	Elliott Soc.Nat.Hist., Proc.	Vol. 1.
Essex Institute, Bulletin	Salem, Mass	Essex Inst., Bull	Vols. 1-18.
Essex Institute, Proceedings	Salem, Mass	Essex Inst., Proc	Vols. 1-6.
Essex Natural History Society, Journal.	Salem, Mass	Essex Nat. Hist. Soc., Jour.	Vols. 1-6.
France, Geological Society, Bulletin	Paris, France	France, Geol.Soc., Bull	1st series: Vols. 1-14; 2d series: Vols. 1-26; 3d series: 1-15.
France, Geological Society, Memoirs.	Paris, France	France Geol. Soc., Mem	1st series: Vols. 1-5; 2d series: Vols. 1-10; 3d series: Vols. 1-4.
Franklin Institute, Journal	Philadelphia, Pa	Franklin Inst., Jour	3d series: Vols. 77-92.
Geological Association (*see* London Geological Association).			
Geological Magazine	London, England	Geol. Mag	1st series: Vols. 1-10; 2d series: Vols. 1-12; decade 3d: Vols. 1-6.
Geological Society of America, Bulletin.	New York, N. Y., and Washington, D. C.	Am. Geol. Soc	Vols. 1, 2.
Geological Society (of London) (*see* London Geological Society).			
Geologist, The	London, England	Geologist	Vols. 1, 2 (1842-1843).
Geologist, The	London, England	Geologist	Vols. 1-7 (1858-1863).
Great Britain (*see* Royal Institution of Great Britain).			
Hamilton Association, Journal and Proceedings.	Hamilton, Ontario	Hamilton Assoc ,Jour. and Proc.	Vols. 1, 2.
Hartford Natural History Society, Transactions.	Hartford, Conn	Hartford Nat. Hist. Soc., Trans.	No. 1 (1836).
Harvard College, Museum of Comparative Zoology, Bulletin.	Cambridge, Mass	Harvard Coll. Mus. Comp. Zool., Bull.	Vols. 1-18.
Harvard College, Museum of Comparative Zoology, Memoirs.	Cambridge, Mass	Harvard Coll. Mus. Comp. Zool., Mem.	Vols. 1-15.
Illinois Natural History Society, Transactions.	Springfield. Ill	Illinois Nat. His. Soc., Trans.	Vol. 1.
International Congress of Geologists, American Committee, Report.		Internat. Cong., Geol. Am. Com., Rep.	
International Congress of Geologists, American Committee, Reports.	Philadelphia, Pa	Internat. Cong., Geol. Am. Com., Rep.	Report for the London meeting.
Iowa Academy of Sciences, Proceedings.	Des Moines, Iowa	Iowa Acad. Sci., Proc.	1887-1889.
Ireland, Royal Academy, Proceedings.	Dublin, Ireland	Ireland Roy. Acad., Proc.	Second series: Vols. 1-3.
Ireland, Royal Geological Society		Ireland Roy. Geol. Soc.	Vols. 1-14.
Ireland, Royal Geological Society, Journal.		Ireland Roy. Geol. Soc., Jour.	
Johns Hopkins University, Circular.	Baltimore, Md	Johns Hopkins Univ., Circ.	Vols. 1-7.
Kansas Academy of Science, Transactions.	Topeka, Kans	Kansas Acad. Sci	Vols. 1-7, 9-11.
Kirtland Society of Natural Science, Papers.	Cleveland, Ohio	Kirtland Soc. Nat. Sci., Papers.	1874.
Liverpool Geological Society, Proceedings.	Liverpool, England	Liverpool Geol. Soc., Proc.	Vols. 1-5.
London Geological Society, Proceedings.	London, England	London Geol. Soc., Proc.	Vols. 1-4.
London Geological Society, Quarterly Journal.	London, England	London Geol. Soc., Quar. Jour.	Vols. 1-44.
London Geological Society, Transactions.	London, England	London Geol. Soc., Trans.	1st series: Vols. 1-5; 2d series: Vols. 1-7.
London Geologists' Association, Proceedings.	London, England	London Geol's. Assoc., Proc.	1st series: Vol. 1; 2d series: Vols. 1-9.

Catalogue of serial publications examined—Continued.

Name.	Published at—	Abbreviation.	Examined,
London Royal Society, Philosophical Transactions.	London, England	London Roy. Soc., Phil. Trans.	From 1837 to 1884.
London, Edinburgh and Dublin Philosophical Magazine and Journal of Science.	London, England	London Philo. Mag.	5th series: Vols. 1–21.
Maclurean Lyceum, Contribution	Philadelphia, Pa	Maclurean Lyc., Cont.	Vol. 1.
Manchester, Geological Society, Transactions.	Manchester, England	Manchester Geol. Soc., Trans.	Vols. 1–25.
Manitoba Historical and Scientific Society, Transactions.	Winnipeg, Canada	Manitoba Hist. and Sci. Soc.; Trans.	Vols. 1–29.
Maryland Academy of Sciences, Transactions.	Baltimore, Md	Maryland Acad. Sci., Trans.	1888, pp. 1–97.
Maryland Academy of Sciences and Literature, Transactions.	Baltimore, Md	Maryland Acad. Sci. Lit., Trans.	Vol 1.
Massachusetts Institute of Technology: Technology Quarterly (*see* Technology Quarterly).			
Meriden Scientific Association, Transactions.	Meriden, Conn	Meriden Sci. Assoc., Trans.	Vols. 1–4.
Minnesota Academy of Science, Bulletin.	Minneapolis, Minn	Minnesota Acad. Sci., Bull.	Vols. 1, 2.
National Academy of Science, Annual.	Washington, D. C., and Cambridge, Mass.	National Acad. Sci., Ann.	Vols. 1–4.
National Academy of Science, Memoirs.	Washington, D. C.	National Acad. Sci., Mem.	Vol. 1.
National Geographic Magazine	Washington, D. C.	Nat. Geog. Mag.	Vol. 1, No. 1–4.
National Institution, Bulletin of the Proceedings.	Washington, D. C	National Inst., Proc	1840–1844.
Neues Jahrbuch für Mineralogie, Geologie und Paleontologie.	Stuttgart, Germany	Neues Jahrbuch	Vols. 1836–1887. Beilage Bd. 1–4.
New Brunswick Natural History Society, Bulletin.	Fredericton, N. B.	New Brunswick Nat. Hist. Soc., Bull.	Vols. 1–6.
New Orleans Academy of Sciences, Papers.	New Orleans, La.	New Orleans Acad. Sci., Papers.	Vol. 1, No. 2.
New Orleans Academy of Sciences, Proceedings.	New Orleans, La.	New Orleans Acad. Sci., Proc.	Vol. 1, No. 1.
Newport Natural History Society, Documents.	Newport, R. I.	Newport Nat. Hist. Soc., Doc.	Documents 2–5.
New York Academy of Sciences, Annals.	New York, N. Y.	New York Acad. Sci., Ann.	Vols. 1–5.
New York Academy of Sciences, Transactions.	New York, N. Y	New York Acad. Sci., Trans.	Vols. 1–10 (No. 1–3).
New York Lyceum of Natural History, Annals.	New York, N. Y	New York Lyc. Nat. Hist., Ann	Vols. 1–11.
New York Lyceum of Natural History, Proceedings.	New York, N. Y	New York Lyc. Nat. Hist., Proc.	Vol. 1 (1870–'71) 2d series Vol. 1 to p. 156.
Nova Scotian Institute of Natural Science, Transactions.	Halifax, Nova Scotia	Nova Scotian Inst., Trans.	Vols. 1–7.
Orleans County Society of Natural Sciences, Transactions and Archives of Science.	Lunenburg, Vt	Orleans (Vt.) Soc. Nat. Sci., Trans.	Vol. 1, No. 1–6.
Ottawa Field-Naturalists' Club, Transactions.	Ottawa, Canada	Ottawa Field-Nat. Club, Trans.	Vol. 1, No. 1–4. Vol. 2, No. 5–7.
Ottawa Naturalist and Transactions of the Ottawa Field-Naturalists' Club.	Ottawa, Canada	Ottawa Nat. and Field-Nat. Club, Trans.	Vol. 1.
Pennsylvania Geological Society, Transactions.	Philadelphia, Pa	Pennsylvania Geol. Soc., Trans.	Vol. 1.
Petermann's Mittheilungen	Gotha, Germany	Petermann's Mitt.	Vols. 1–33; Ergänzungsbände 1–12.
Philadelphia Academy of Natural Sciences, Journal.	Philadelphia, Pa	Philadelphia Acad. Nat. Sci., Jour.	1st series, Vols. 1–8; 2d series, Vols. 1–8.
Philadelphia Academy of Natural Sciences, Proceedings.	Philadelphia, Pa	Philadelphia Acad. Nat. Sci., Proc.	Vols. 1–39, to 1890.
Philosophical Society of Washington, D. C. (*see* Washington Philosophical Society).			
Portland Society of Natural History, Journal.	Portland, Me	Portland Soc. Nat. Hist., Jour.	Vol. 1, No. 1.
Portland Society of Natural History, Proceedings.	Portland, Me	Portland Soc. Nat. Hist., Proc.	Vol. 1.
Pottsville Scientific Association, Bulletin.	Pottsville, Pa	Pottsville Sci. Assoc., Bull.	1855.
Royal Institution of Great Britain, Journal.	London	Roy. Inst. Gr. Br., Jour.	Vols. 1, 2.
Royal Irish Academy (*see* Ireland, Royal Academy).			

Catalogue of serial publications examined—Continued.

Name.	Published at—	Abbreviation.	Examined.
Royal Society, London (*see* London, Royal Society).			
Saint Louis Academy of Sciences, Transactions.	Saint Louis, Mo	Saint Louis Acad. Sci., Trans.	Vols. 1–4; Vol. 5, pp. 1–336.
School of Mines, Quarterly	New York, N. Y	School of Mines, Quart.	Vols. 1-11.
Science	Cambridge. Mass., and New York, N.Y.	Science	Vols. 1-14.
Science	New York, N. Y	Science (ed. by John Michels).	Vols. 1, 2.
Smithsonian Institution, Annual Report.	Washington, D. C	Smith. Inst.. Ann. Rep.	1853–1887.
Smithsonian Institution, Contribution to Knowledge.	Washington, D. C	Smith. Inst., Cont. Knowl.	Vols. 1–25.
Smithsonian Institution, Miscellaneous Collections.	Washington, D. C	Smith. Inst., Misc. Coll.	Vols. 1–12.
Societé géologique de France (*see* France, Geological Society).			
Technology Quarterly	Boston, Mass	Tech. Quart	Vols. 1–3.
Texas State Geological and Scientific Association, Bulletin.	Houston, Tex	Texas State Geol. and Sci. Assoc.. Bull.	Vol. 1, No. 1–6.
Trenton Natural History Society, Journal.	Trenton, N. J	Trenton Nat. Hist. Soc., Jour.	Vol. 1.
United States Geological Survey, Annual Reports.	Washington, D. C	U. S. Geol. Surv., Ann. Rep.	1st–7th.
United States Geological Survey, Bulletin.	Washington, D. C	U. S. Geol. Surv., Bull.	No. 1–50.
United States Geological Survey, Mineral Resources.	Washington, D. C	U. S. Geol. Surv., Min. Resourc.	1883–1887.
United States Geological Survey, Monographs.	Washington, D. C	U. S. Geol. Surv., Mono.	Vols. 1-14.
United States National Museum, Bulletin.	Washington, D. C	U. S. Nat. Mus., Bull.	Vol. 1.
United States National Museum, Proceedings.	Washington, D. C	U. S. Nat. Mus., Proc.	Vols. 1-10.
Vassar Brothers' Institute, Transactions.	Poughkeepsie, N. Y	Vassar Brothers' Inst., Trans.	Vols. 1–4.
Virginias, The	Staunton, Va	The Virginias	Vols. 1–6.
Washburn College Laboratory of Natural History, Bulletin.	Topeka, Kans	Washburn Coll., Bull.	Vol. 1.
Washington Biological Society, Proceedings.	Washington, D. C	Washington Biol. Soc., Proc.	Vols. 1–3.
Washington Philosophical Society, Bulletin.	Washington, D. C	Washington Phil. Soc., Bull.	Vols. 1–10.
Wisconsin Academy of Science, Arts, and Letters, Bulletin.	Madison, Wis	Wisconsin Acad. Sci., Bull.	No. 1–5.
Wisconsin Academy of Science, Arts, and Letters, Transactions.	Madison, Wis	Wisconsin Acad. Sci., Trans.	Vols. 1–5.
Wyoming Historical and Geological Society, Proceedings and Collections.	Wilkesbarre, Pa	Wyoming Hist. and Geol. Soc., Proc. and Coll.	Vols. 1–3.
Zeitschrift der deutschen geologischen Gesellschaft.	Berlin	Deutsch., Zeitschr. geolo. Gesell.	Whole set.

PLAN OF THE INDEX.

This index consists of principal and secondary entries arranged in a single alphabetic series.

Principal entries.—These consist of the names of books and papers arranged under authors. The author's name is printed in **BLACK FACED** (capitals) type, with a date to the right in the same type. The date designates the year of publication, or, instead of this, in the case of many serials, the date at which the paper appeared, or was read. When two or more papers bear the same date, the second one is designated as *a*, the third as *b*, and so on. When a paper has been published in more than one edition, the edition given first in the description of the book is the one referred to.

The abstract following the description of a paper indicates briefly its contents so far as it relates to the Newark system. References are given to so-called Newark rocks on Prince Edward island, for the reason that the index was compiled before it was concluded that the Newark system is not there represented.

Secondary entries.—The chief words of the secondary or subject entries are printed in **black faced** (small letters) type and in these the reader is referred by author's name and date to the principal entries in **BLACK FACED** (capitals) type.

These secondary entries include:

(1) Places where observations on the Newark system have been made. In these entries the method of locating observations in use by each author has been followed. For example, a locality may be referred to in reference to its proximity to a town, a mountain, a river, etc., by different writers. This necessarily leads to lack of uniformity in the index, but when practicable, cross-references from one method of entry to others have been made.

(2) Under the names of states, the principal papers relating to the rocks of the Newark system within their borders.

(3) The works of authors cited in publications not their own. These are referred to under the name of the author cited, but the information contained in the reference or quotation is treated as a portion of the paper in which it appears.

(4) Under the head of Plants (fossil), Invertebrates (fossil), and Vertebrates (fossil), references to papers containing descriptions of species or genera.

(5) In structural and general geology, references to the following subjects whenever the information recorded seemed sufficiently definite:

Age (discussion or determination of).
Analyses.
Anticline.
Arkose.
Coal.
Coke, natural.
Conformity.
Conglomerate.
Copper.
Dip.
Dike.
Fault.
Footprints.
Gypsum.
Limestone.
Map, geological.
Metamorphism.
Metamorphism, contact.
Minerals (principal papers only).
Oil.
Raindrop impressions.
Salt.
Sandstone.
Shale.
Shrinkage cracks.
Strike.
Synclinals.
Trap.

In making references to the subjects mentioned above, as great consistency has been observed as the diversity of the papers indexed would allow.

Besides the subjects enumerated some irregular entries have been inserted, but not systematically noted for the whole body of literature examined. An effort has been made to complete the list up to 1891, but a few papers published in 1890 were received too late to be fully indexed. A further delay in publication has enabled me to introduce references to a few published in 1891, but for these only a limited number of secondary entries have been inserted.

When not otherwise indicated the papers referred to are octavo.

In preparing this index I have been greatly assisted by Mr. Nelson H. Darton, who has permitted unrestricted use of the manuscript of an unpublished "Author's Catalogue of North American Geology," and has assisted me in many other ways. I am also indebted to Prof. W. O. Crosby, for a short bibliographic list which has been used in verification.

LITERATURE.

Abbeville, S. C. Description of trap dikes near (Tuomey, '44, pp. 11-12).
Trap dikes near (Hammond, 1884, p. 466).

ABBOT, [S. L.] Cited on fossil footprints. (E. Hitchcock, 1843*a*, p. 260).

Abbotstown, Pa. Character of strata near (H. D. Rogers, '58, vol. 2, p. 679).
Conglomerate near (H. D. Rogers, '58, vol. 2, p. 680).
Dip near (Frazer, '76, p. 101).

Acadia. Section of the rocks of (Dawson, '78 Pl. op., p. 20).

ACKERLY, S. Cited on the character of the rocks forming the Palisades, N. J. (Cooper, '22, p. 240).

ADAMS, C. B. **1846.**
Second annual report on the geology of the state of Vermont. Burlington Vt., pp. 1-267.
Contains a brief account of the Newark system in general, pp. 101-102. Discusses the amount of erosion indicated by the trap dikes of the Connecticut valley and of Vermont. States that some of the material forming the Newark rocks of the Connecticut valley came from the North, pp. 159-162.

ADAMS, C. B. **1846a.**
Notice of a small Ornithichnite.
Am. Jour. Sci., 2d ser., vol. 2, pp. 215, 216.
Describes and gives two outline figures of a small footprint from Westfield, Conn.

ADAMS, C. B. **1860.**
Elements of geology.
See Gray and Adams, 1860.

ADAMS [C. B.]. Cited on the mode of formation of the Newark rocks of the Connecticut valley (Lea, '53, pp. 191-192).

Adams County, Pa. Brief report on (Lesley, '85, p. xxi, pl. 1).
Contact metamorphism in (H. D. Rogers, '58, vol. 2, p. 691).
Detailed account of copper ore in (Frazer, '80, pp. 299-304).
Dip in trap rock in (H. D. Rogers, '58, vol. 2, p. 691).
Geological map of (Lesley and Frazer, '76).
Red shale in (H. D. Rogers, '58, vol. 2, p. 677).
Report on the geology of (Frazer, '76).
Report on the geology of (Frazer, '77).

Adams county, Pa.—Continued.
Section of the Newark in (Frazer, '77*a*).
Strike of trap dikes in (H. D. Rogers, '58, vol. 2, p. 691).
Trap dikes of (H. D. Rogers, '58, vol. 2, p. 691).
Trap rocks of (Frazer, '75*a*).

Advocate harbor, N. S. Rocks at (Gesner, '36, p. 233).

AGASSIZ, LOUIS. **1833–1843.**
Recherches sur les poissons fossiles.
Neuchatel, 5 vol. folio.
Describes and figures fossil fishes from the Newark system, vol. 2, pp. 43, 159; pl. 8, 14c.

AGASSIZ, [LOUIS]. **1850.**
[On the age of the Newark rocks of the Connecticut valley.]
In Boston Soc. Nat. Hist., Proc., vol. 3, pp. 336-337.
Remarks on a paper by C. T. Jackson.

AGASSIZ, [LOUIS]. **1851.**
[Remark on the geological position of the Newark system as indicated by fossil plants.]
In Am. Ass. Adv. Sci., Proc., vol. 5, p. 46.
A brief remark in discussion of a paper by W. C. Redfield.

AGASSIZ, LOUIS. **1853a.**
[Geological position of the Newark system as indicated by fossil fishes.]
In Am. Ass. Adv. Sci., Proc., vol. 4, p. 276.
Discussion of a paper by W. R. Johnson.

AGASSIZ, LOUIS. **1853.**
[Remarks on the age of the Deep river coal field, N. C.]
In Am. Acad., Proc., vol. 3, 1852-1857; p. 69.
Remarks following a discussion concerning the age of the Deep river coal field, N. C., by C. T. Jackson and W. B. Rogers.
States that the fossil fishes of the Newark system indicate a geological position between the Trias and Lias of Europe.

AGASSIZ, LOUIS. **1855.**
[Remarks on the footprints of the Connecticut valley.]
In Am. Acad., Proc., vol. 3, 1852-1857, p. 193.
States reasons for doubting whether all the so-called footprints of birds in the Connecticut river sandstone were in reality produced by birds.

AGASSIZ, [LOUIS]. 1858.

[Remarks on certain crustacean footprints from the sandstone of the Connecticut valley.]

In Ichnology of New England, by Edward Hitchcock, p. 166.

A brief extract from a letter in reference to the footprints of crustaceans.

AGASSIZ, LOUIS. 1859.

On "Marcou's geological map of North America."

In Am. Jour. Sci., 2d ser., vol. 27, pp. 134–137.

Republished in "Reply to the criticisms of James D. Dana," by Jules Marcou, Zurich, 1859, pp. 26–30.

AGASSIZ, [LOUIS]. 1860.

[On the age of red sandstone in New Brunswick and on the south shore of Lake Superior.]

In Boston Soc. Nat. Hist., Proc., vol. 7, p. 398.

Discussion of a paper by C. T. Jackson.

Cited as to the age of the coal fields of North Carolina (Emmons, '56, pp. 272, 275).

Cited on the age of the Newark system (Hitchcock and Hitchcock, '67, p. 416. Lea, '53, p. 188. Lea, '58). Marcou, '53, p. 41. Murchison, '43.

Cited on the age of the Richmond coal field, Va. (Taylor, '48, p. 47. Lyell, '47, p. 275. Marcou, '49, p. 274). Marcou, '58, p. 16.

Cited on the classification of fossil fishes from the Connecticut valley (J. H. Redfield, '56).

Cited on the deposition of copper in amygdaloids, etc. (Chapman, '56, pp. 43–45).

Cited on the early discovery of fossil fishes in the Newark system (Newberry, '88, p. 19).

Cited on fossil fishes (C. H. S. Davis, '87, p. 21. Egerton, '49, pp. 4, 8. E. Hitchcock, '41, p. 459. Newberry, '88. J. H. Redfield, '36).

Cited on fossil fishes (W. C. Redfield, '41, p. 25).

Cited on fossil footprints (Deane, '47. Silliman and Dana, '47).

Cited on Marcou's geological map of North America (Marcou, '59, pp. 26–30).

Cited on Newark flora (Marcou, '90).

Cited on number of phalanges in the toes of birds (Silliman, Silliman, jr., and Dana, '47.

Reference to fossil fishes described by (Newberry, '88, p. 24).

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In Am. Ass. Adv. Sci., Proc., vol. 24, part 2, pp. 106-109.
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[On the occurrence of fossil fishes at Middlefield and Westfield, Conn.]
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Brief mention that fossil footprints have been discovered at Middletown, Conn.

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In Am. Jour. Sci., 2d ser., vol. 37, p. 371.
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The eighth volume treats of the Triassic; in it chapter 12 is devoted to a review of the Triassic formation of North America, pp. 633–656. A general résumé of the Triassic formation wherever found is given on pp. 663–672.

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In Observations on the geology of southeastern New Brunswick, made principally during the summer of 1864 by Prof. L. W. Bailey, Messrs. George F. Matthew and C. F. Hartt, prepared and arranged with a geological map by L. W. Bailey, Fredericton, pp. 1-122, 130, map.

Contains an account of certain terranes erroneously referred to the Newark system by Gesner, pp. 5, 6; also a list of localities where Newark rocks do occur, p. 5, and a tabular view of the rocks of New Brunswick, p. 13.

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A somewhat detailed description of the geology of Grand Manan and the small islands near it. The occurrence of sandstone beneath trap at Dark harbor is described.

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In describing what is considered a moraine of Permian age, mention is made of an unconformity at what is supposed to be the top of the Carboniferous.

BAIN, F. Cited on the geology of Prince Edward island (Bain and Dawson, '85, pp. 156-158).

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Bainbridge, Pa. Boundary of the Newark system near (Frazer, '80, p, 13, 34. Frazer, '82, p. 123. Lea, '58, p. 92. H. D. Rogers, '58, vol. 2, p. 668).

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Bird tracks at Middletown, Conn., in the new red sandstone.

In Am. Jour. Sci., vol. 31, p. 165.

An extract from a letter to B. Silliman (by J. Barratt?) relating to the discovery of fossil footprints at Middletown, Conn.

BARRATT, JOSEPH. 1845.

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In Am. Assoc. Geol. and Nat., Proc., 6th meeting, p. 23.

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In Elisha Mitchell Sci. Soc., Jour., 1885–'86, pp. 51-53.

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Baxters harbor, N. S. Minerals of (Willimott, '84, p. 27L).

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In France, Geol. Soc. Bull, 1st ser., vol. 4, pp. 225–291.

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Shale occurring near (Percival, '42, p. 433).

Beavertown, N. J. Trap hill near (Cook, '68, p. 186).

Bechtelsville, Pa. Trap dikes near (d'Invilliers, '83, p. 200).

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In Am. Jour. Sci., vol. 36, pp. 107–114.

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In Am. Jour. Sci., vol. 44, p. 54–60.

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BEECHER, C. E. Cited on a fossil shell from the Newark rocks of New Jersey (Nason, '89, p. 29).

Beech island, Va. Boundaries of the Newark near (W. B. Rogers, '40, p. 63).

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Bell coal mine, Va. Notes on (Taylor, '35, pp. 284, 285).

Belle mountain, N. J. Description of (Cook, '68, p. 191. Cook, '82, p. 61. Darton, '90, p. 68. H. D. Rogers, '40, pp. 151, 152).

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Character of the rocks in quarries near (Nason, '89, p. 22).

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Description of copper mines near (H. D. Rogers, '40, p. 160. Rogers, '36, pp. 167–168).

Description of quarries at (Cook, '81, pp. 44–47).

Description of sandstone near (Cook, '68, p. 209).

Dip at (Cook, '68, p. 196).

Fault near (Cook, '83, p. 25).

Fossil bone from (Cook, '85, p. 95).

Fossil plants at (Akerly, '20, p. 36. Cook, '79, p. 26).

Fossil tooth found at (Pierce, '20, p. 194).

Mention of fossil bones found at (Finch, '26, p. 212).

Mention of fossil fern from (Mitchill, '26, p. 6).

Mention of fossils found at (Mitchill, '28, p. 9).

Plant remains in sandstone near (Nason, '89, p 23–28).

Quarries of (Shaler, '84, p. 141).

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Supposed Lepidodendron from (Lesquereux, '79, pp. 26, 27).

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Vertebrate fossils reported to have been found near (Nason, '89, p. 28).

View of quarry at (Cook, '82, pl. 3).

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Bellona arsenal, Va. Natural coke near (Clifford, '87, p. 24).

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In report on the mining industries of the United States [etc., etc.].
By Raphael Pumpelly. In Tenth Census of the United States, 4to vol. 15, pp. 261–288, and a map.
Contains a geological map of the western part of Virginia, showing Triassic area on the James and Staunton rivers, pl. op., p. 261.

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Oolite at Franklin in (Eaton, '30).

Bergen hill, N. J. Analysis of trap from (Cook, '68, p. 215).
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Bored well at (Cook, '85, p. 122).
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Calcite from (vom Rath, '77).
Contact of trap of, with sandstone, slates, etc., beneath (Russell, '80, pp. 37–41).
Description of (Cook, '82, pp. 44, 45; Russell, '80, p. 36).
Description of hayesine from (Darton, '82*a*).
Description of indurated shales near (Darton, '83*a*).
Description of minerals found at (Beck, 43).
Fault in trap ridge at (Darton, '90, p. 42).
Inclination of west face of, at New Durham (Darton, '83).
Joints in trap at (Cook, '68, pp. 204, 205).
Minerals of the Weehawken tunnel (Chamberlin, '83. Darton, '82).
Native iron in the trap of (Cook, '74, p. 57).
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Paving stones from (Cook, '79, p. 20).
Paving stone quarries at (Cook, '68, pp. 522, 523).
Section of (Cook, '68, pp. 230, 231, 232).
Thickness of trap sheet near (Darton, '90, p. 44).
Trap in tunnel at (Credner, '65 pp. 392–394).
Trap quarries at (Shaler, '84, p. 145).
Trap rock of (Ward, '79, p. 150).
Value of trap rock quarried at (Cook, '81, p. 61).

Bergen neck, N. J. Description of (Cook, '68, pp. 176–178).
Trap exposed at (Russell, '80, p. 36).

Bergen point, N. J. Boundary of trap outcrop at (Cook '68, p. 177).
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Brief reference to trap hills near (H. D. Rogers, '36, p. 159. Russell, '78, p. 241).
Outcrops of trap rock on (Darton, '90, p. 38).
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Coal found in (E. Hitchcock, '41, p. 139).
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Contact metamorphism in (Percival, '42, p. 320).
Limestone near (Percival, '42, p. 443).
Map of trap ridges and faults near (W. M. Davis, '89*c*, p. 424).
Overflow trap sheets near (W. M. Davis, '88, p. 464).
Reference to a locality for fossil fish (J. H. Redfield, '36).
Reference to the occurrence of zinc at (E. Hitchcock, '35, p. 232).
Report of the finding of coal at (E. Hitchcock, '23, vol. 6, p. 63).
Trap ridges near (Percival, '42, p. 365).
View of trap ridges near (W. M. Davis, '89*c*, p. 425).

Berlin, Pa. Character of strata near (H. D. Rogers, '58, vol. 2, p. 679).
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Bernardston, Mass. Concerning the origin of the conglomerate in (E. Hitchcock, '35, p. 244).
Conglomerate in (E. Hitchcock, '35, p. 214. E. Hitchcock, '41, p. 442).
Dip of sandstone in (E. Hitchcock, '35, p. 223).
Discovery of limestone in (E. Hitchcock, '35, pp. 38–39).
Junction of Newark system with slate in (E. Hitchcock, '35, p. 214).

Bernardville, N. J. Black shale with coal near (Nason, '89, p. 28).
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Boundary of Second mountain trap near (Cook, '68, pp. 183, 185).
Dip in shale near (Cook, '82, p. 29).
Diverse dips near (Nason, '89, p. 18).
Isolated trap hill near (Nason, '89, p. 37).
Trap ridge near (Cook, '82, p. 57).

Bernardsville station, N. J. Trap sheets near (Darton, '90, p. 29).

BEST, P. Quarries of, near Stockton, N. J (Cook, '81, p. 59).

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Of the writings of James Dean (Bodwich, '61. Dean, '61, p. 13, 14).
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With annotations (Miller, '79–'81, vol. 2).

Big dam, Pa. Boundary of the Newark near (d'Invilliers, '83, p. 198).
Dip of conglomerate near (d'Invilliers, '83, pp. 127, 191, 221).

Big pond, N. J. (See Franklin Lake.)

Big snake hill, N. J. Dip at (Cook, '68, p. 196).
See Snake hill (Cook, '68, pp. 178, 179).

Bird in Hand, Pa. Analysis of trap from (Genth, '81, pp. 133–134).

Birds, fossil bones of. From North Carolina (Emmons, '57, pp. 148, 149).

From Portland, Conn. (W. B. Rogers, '60*a*).

Birdsboro, Pa. Trap dikes near (d'Invilliers, '83, pp. 200, 201).

Bishop's brook, N. S. Copper near (Willimott, '84, p. 20L).

Bitumen. In amygdaloid trap in Connecticut (Percival, '42, p. 320).

In bituminous shale, Connecticut (d'Percival, '42, pp. 451, 452).

In Connecticut, brief statement concerning (Percival, '42, p. 428).

In Connecticut and New Jersey (J. D. Dana, '78).

Indurated, found near Farmington, Conn. (Percival, '42, pp. 375–376).

In indurated shale near Bluff Head, Conn. (Percival, '42, p. 345).

In shale at Hart's Mills, Conn., mention of (Percival, '42, p. 443).

In trap from Connecticut E. S. Dana, '75).

Near Somerville, N. J., brief account of (Beck, '39).

Black Bear tavern, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).

Blackheath, Va. Analysis of coal from (De La Beche. '48, p. lxv).

Blackheath coal mine, Va. Analysis of coal from (Williams, '82, p. 82).

A visit to (Lyell, '49, p. 284).

Brief account of (Lyell, '47, pp. 263, 264. Macfarlane, '77, p. 507).

Condition of (Clifford, '87, p. 2).

Explosions in (Taylor, '48, p. 49).

Depth of W. B. Rogers, 43*b*, p. 535).

Description of fossil fishes from (Newberry, '88, p. 62).

Fossil crustaceans from (Jones, '62, p. 86).

Fossil plants from (Fontaine, '83, p. 4).

Mention of Daddow and Bannan, '66, p. 401).

Notes on (Taylor, '35, pp. 284, 285, 292).

Note on faults in (Taylor, '35, p. 292).

Reference to (Clifford, '87, p. 24, pl. 4).

Section at (Clifford, '87, pl. 4).

Section at, showing coal on granite (Lyell, '47, p. 266).

Situated in an isolated basin (Heinrich, '78, p. 232).

Thickness of coal in (Lyell, '66, p. 452. Taylor, '35, p. 282).

Blackman' mine, S. C. Description of trap dikes in (Tuomey, '44, p. 12).

Black mountain, Mass. Description of scenery near (E. Hitchcock, '23, vol 7, p 12).

Black pond, Conn. Trap ridges near (Percival, '42, pp. 351, 367).

Black rock, Conn. Description of trap ridges near Percival, '42, p. 329).

Black rock, N. S. Description of (Gesner, '36, pp. 198–203).

Minerals of (Gesner, '36, p. 199–203. Willimott, '84, p. 26L).

Submerged ridges near (Dawson, '78, p. 96. Perley, '52, p. 159).

Blacks eddy, N. J. Description of trap, contact metamorphism, etc., near (H. D. Rogers, '40, p. 156).

Blackwells mills, N. J. Dip at (Cook, '68, p. 197).

Dip in sandstone at (Cook, '68, p. 204).

Dip in shale at (Cook, '82, p. 25).

Origin of trap rock near (Darton, 89, p. 139).

Section of trap dike at (Cook, '68, p. 204).

Small dikes near (Darton, '90, p. 69).

Small outcrop of trap near (Nason, '89).

Trap dike near (Cook, '68, p. 204. Cook, '87).

BLAINVILLE, H. D. DE. Cited on fossil fishes from the Newark system (Newberry, '88, p. 24).

BLAKE, W. P. **1874.**

Geological map of the United States.

See Hitchcock and Blake, 1874.

Blawenburg N. J. Dip in shale at (Cook, '82, p. 25).

BLAYDEN, JOHN. Cited on section at Midlothian, Va. (Clifford, 87, p. 12).

BLISS, GEORGE. **1850.**

Discovery of fossil remains in the valley of the Connecticut.

See Wells and Bliss, 1850.

Blomidon, N. S. Altitude of (Gesner, '36, pp. 214, 222).

Amygdaloid beneath basaltic trap at (Dawson, '78, pp. 90, 91.)

Brief description of (Russell, '78, p. 221).

Brief reference to (Gesner '49).

Character and height of (Marsters, '90).

Coast section near (Dawson, '47 p. 56).

Contact metamorphism at Ells, '85, p. 7E).

Description of (Dawson, '78, pp. 90–94. Gesner, '36, pp. 210–229).

Description of Newark outcrops at (Dawson, '47, pp. 55).

Dip of sandstone at (Dawson, '78, pp. 90, 91. Gesner, '36, p. 222).

General account of (Honeyman, '79, pp. 27, 28).

General account of petrography of trap from (Honeyman, '85, pp. 122–124).

Height of (Dawson, 78, p. 90).

Iron ore at (Gesner, '36, p. 217).

Mode of formation of amygdaloid and trap at (Dawson, '78, p. 93).

Rocks of (Gesner '36, pp. 72, 73, 74, 80, 170).

Section of cliff at (Lyell, '45, vol. 2, p. 172).

Supposed Carboniferous age of (Dawson, '78, p. 109).

Trap above sandstone at (Dawson, '78, p. 90).

Trap rocks at (Gesner, '43).

View of, in 1846 (Dawson, '78, pl. op. p. 90).

(See also Cape Blomidon; North mountains).

Bloomfield, N. J. Quarries at (Cook, '79, p. 19).

Bloomsburg, N. J. Section from, to Dean's Pond, N. J. (Cook, '68, p. 199 and map in portfolio).

Blue hills, Conn. Description of (Percival, '42, p. 372).

Bluff head, Conn. Description of trap ridges near (Percival, '42, pp. 337–339, 344, 352).

Limestone near (Percival, '42, p. 444).

Topographic form of trap ridge near (Percival, 42, p. 303).

Blunt's coal mine, Va. Notes on (Taylor, '35, p. 284).

BODWICH, HENRY I. **1861.**

Biographical notice [of James Deane].

In Ichnographs from the sandstone of Connecticut river, by James Deane, pp. 5–14.

Contains an incomplete list of papers by James Deane, relating to fossil footprints from the Connecticut valley.

Boggan's cut, N. C. Analysis of coal from (Kerr, '75, pp. 294, 295).

BOLTON, H. C. Cited on hydrocarbons in the trap of Connecticut at (Russell, 78*b*).

Bone, fossil, from Belleville, N. J. (Cook, '85, p. 95).

At Belleville, N. J. Mention of (Finch, '26, p. 212).

Bones, fossil, from East Windsor, Conn. (John Hall, '21. Percival, '42, p. 449. Silliman, '20. N. Smith, '20).

An account of the finding of (E. Hitchcock, '20, vol. 6, p. 43).

Description of (Wyman, '55).

Bones, fossil, from the Connecticut valley (Harlan, '34, pp. 80–81, 83, 87. E. Hitchcock, '41, pp. 503-504, pl. 49. E. Hitchcock, '58, p. 186. Marsh, '89. Silliman, '37).

Bones, fossil. (See, also, Vertebrates, Fossil).

Bonhamtown, N. J. Boundary of Newark near (Cook, '68, pp. 175, 176).

Bonnaughtown, Pa. Dip of strata near (Frazer, '80, p. 300).

Exploration for copper ore near (Frazer, '77, pp. 263–264).

On the occurrence of copper ore at (Frazer, '77*b*. Frazer, '80, p. 300).

Bonnell, N. J. Limestone at (Cook, '82, p. 43).

Boone's mill, Pa. Dip of strata, and exposure of trap near (d'Invilliers, '83, p. 216).

Boonton, N. J. Boundary of Newark at (Cook, '68, p. 175. Cook, '89, p. 11).

Brief record of the finding of a fossil footprint near (Russell, '79).

Character and origin of the Newark conglomerate at (Russell, '78, p. 253).

Coal in thin seams at (Cook, '78, p. 110).

Color of the strata near (Newberry, '88, p. 8).

Conglomerate composed of gneissic pebbles near (Nason, '89, p. 21).

Conglomerate near (Cook, '68, pp. 210, 211. Russell, '78, pp. 232, 233).

Contact of Newark rocks and gneiss near (H. D. Rogers, '40).

Dip in shale at (Cook, '82, p. 30.)

Dip of sandstone near (Cook, '68, p. 196. Cook, '79, p. 30).

fossil footprints from near (Cook, '68, p. 174. Cook, '79, p. 28. C. H. Hitchcock, '88, p. 122).

Footprints found near (Nason, '89, p. 28).

Mention of (Russell, '78, p. 223).

Fossil estheria and fish scales found near (Nason, '89, p. 30).

Fossil fishes from (Cook, '68, p. 174. Cook, '79, p. 27. Newberry, '88, p. 20).

Boonton, N. J.—Continued.

Fossil fishes from. Descriptions of (Newberry, '78. Newberry, '88. W. C. Redfield, '41).

Fossil fishes from, in New York State Cabinet (Anonymous, '54).

Fossil fishes from. List of (De Kay, '42).

Fossil fish from. Mention of (W. C. Redfield, '43).

Fossil footprints from near (Cook, '68, p. 174. Cook, '79, p. 28. C. H. Hitchcock, '88, p. 122).

Mention of the occurrence of ripple-marks, suncracks, raindrop impressions, and footprints at (Russell, '78, p. 225).

Plant remains in sandstone near (Nason, '89, p. 28).

Section from, to Jersey City, N. J. (Cook, '85, pl. op. p. 109).

Section from, to Passaic, N. J. (Cook, '68, p. 199, and map in portfolio).

Bound Brook, N. J. Copper mine near (Cook, '68, p. 677–678).

Dip in shale near (Cook, '79, p. 30. Cook, '82, p. 25).

Dip near (Cook, '68, p. 196).

Elevation of First mountain at (Cook, '82, p. 49).

Fossil estherias found near (Nason, '89, p. 30).

Fossil fishes near (Cook, '79, p. 27).

Gap in First mountain near (Cook, '82, p. 50).

Mention of the occurrence of ripple-marks, suncracks, raindrop impressions, and footprints at (Russell, '78, p. 225.

Strata exposed near (H. D. Rogers, '40, p. 128).

Synclinal axis near (H. D. Rogers, '40, pp. 128, 129).

Trap hills near, brief reference to (H. D. Rogers, '36, p. 159).

Trap near, columnar (Cook, '68, p. 203).

Trap near, vesicular (Darton, '90, p. 28).

Trap ridge near, character of (Russell, '80, p. 41).

Trap ridge near, course of (Cook, '82, p. 49 Nason, '89, p. 34).

Bound Brook gap, N. J. Boundary of First mountain trap at (Cook, '68, p. 180, 182).

Bout island, N. S. Coast section near (Dawson, '47, p. 56).

BOUVÉ, [T. T.] **1854.**

[Remark on raindrop impressions, footprints, etc., on certain specimens of sandstone belonging to the Boston Society of Natural History.]

In Boston Soc. Nat. Hist., Proc., vol. 5, p. 29–31.

BOUVÉ, T. T. **1859.**

[Who first discovered the footprints in the sandstone of the Connecticut valley.]

In Boston Soc. Nat. Hist., Proc., vol. 7, p. 49–53.

BOUVÉ, T. T. **1861.**

[Note on the plates illustrating ichnographs from the sandstone of Connecticut river.]

In ichnographs from the sandstone of Connecticut river, by James Deane, p. 17.

BOUVÉ, T. T.—Continued.

Thirty-seven of the plates in the work referred to were drawn on stone by James Deane. Nine other plates are photographs.

BOUVÉ, T. T. Remarks on insect larvæ from the Connecticut valley (Scudder, '67).

BOWEN, GEORGE T. 1824.

[Analysis of a siliceous hydrate of copper from Summerville, New Jersey.]

In Am. Jour. Sci., vol. 8, pp. 118-120.

Analysis given.

Boyce's mill, N. C. Breadth of Newark rocks near (Olmstead, '24, p. 12).

BOYD, S. W. Mention of observations by (W. B. Rogers, '54, p. 19).

Boyertown, Pa. Boundary of the Newark near (H. D. Rogers, '41, pp. 16, 39).

Conglomerate near (d'Invilliers, '83, p. 202).

Contact of the Newark and Potsdam near (d'Invilliers, '83, p. 198).

Iron mines at (d'Invilliers, '83, pp. 317-333, maps in atlas, H. D. Rogers, '39, p. 22).

Sandstone and trap at (d'Invilliers, '83, p. 203).

Trap dike near, description of (Frazer, '80, p. 29).

Trap dikes near (d'Invilliers, '83, pp. 48, 200, 207, 208, 304).

BRADLEY, F. H. Cited on the cause of the tilting of the Newark (W. M. Davis, '83, p. 303).

BRADLEY, FRANK H. 1875.

Geological chart of the United States east of the Rocky mountains and of Canada.

New Haven, Conn. A folded pocket map, scale about 100 miles to 1 inch. Geological formations indicated by dots and lines in black.

Indicates the distribution of the Newark system.

BRADLEY, FRANK H. 1876.

On a geological chart of the United States east of the Rocky mountains and of Canada.

In Am. Jour. Sci., 3d ser., vol. 12, pp. 86-291.

Mention is made of trap dikes in metamorphic region of North Carolina, South Carolina, Georgia, and Alabama. The opposite dips of the two Newark areas in North Carolina are accounted for as being the border remnants of a great anticlinal. The same hypothesis is suggested to account for the opposite dips in the New Jersey and Connecticut valley areas.

Braggtown, Pa. Calalogue of specimens of sandstone, etc., from near (Fraser, '77, pp. 332-381).

Sandstone from (C. E. Hall, '78, pp. 33, 36).

Branford, Conn. Brief account of trap near (E. Hitchcock, '23, vol. 6, p. 44).

Branford harbor, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 419-420).

Brassfields, N. C. Rocks exposed at (Emmons, '56, p. 243).

Breccia, along the Potomac (Cornelius, '18, p. 216).

Dip of, near Center valley, Pa. (C. E. Hall, '83, pp. 232, 233).

Breccia—Continued.

From Connecticut, microscopical structure of (Davis and Whittle, '89, pl. 4).

From Point of Rocks, Md., illustration of (Shaler, '84, pl. 45).

In Connecticut (Davis and Whittle, '89).

Near Feltville, N. J., origin of, considered (Darton, '89, p. 135).

Or Trap-tuff at cape D'Or, N. S. (Jackson and Alger, '33, p. 263).

Volcanic, of the Connecticut valley, described (E. Hitchcock, '47*a*, p. 200.)

Brentville, Va. Boundary of Newark near (Heinrich, '78, p. 236. W. B. Rogers, '40, p. 62).

BREWER, WILLIAM H. [1890.]

Warren's New Physical Geography.

Philadelphia, 4to, pp. 1-144.

Contains a geological map of the United States, p. 137.

Brewer and Edgworth gold and copper mine, S. C. An account of (Leiber, '56, p. 51).

Brickerville, Pa. Trap boulders near (Frazer, '80, p. 40).

Brick clay on Prince Edward island (Dawson and Harrington, '71, pp. 33, 34).

Bridge point, Pa. Dip of Newark rocks near (Lewis, '85, p. 452).

Trap dikes near (Lewis, '85, p. 453).

Bridgeport, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 416-417).

Bridgeport, Pa. Boundary of the Newark near (C. E. Hall, '81, pp. 22, 83-84).

Isolated Newark area near (C. E. Hall, '81, p. 22).

Trap dike near (Lewis, '85, p. 440).

Bridgetown, N. S. Note on mineral near (Alger, '27, p. 231).

Bridgetown, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 53).

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Contact metamorphism at (Jackson and Alger, '33, p. 257).
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Description of (Gesner, '36, pp. 230–233. Jackson and Alger, '33, p. 265).
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Amygdaloid at (Gesner, '36, pp. 234, 238).

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Breccia at (Jackson and Alger, '33, p. 263).
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Chapter III: Explorations in the Deep river coal field: Farmville. Egypt shaft. Taylor place. Examinations at Gulf. Between and Evans' place. Slope at Evans' place. Between the Evans and Gardner places. Semi-anthracite at Wilcox place. Semi-anthracite at Gardner place. Murchison plantation. Fooshee plantation.
Chapter IV: Commercial value of the Deep river coal field. Distance to markets. Distance of other coal fields. Cost of mining. Quality of the coal. Workable area. Available tonnage. Obstacles to successful mining. Method of development. General conclusions.
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Picture of (Gesner, '36, p. 206).

Sketch of (Emmons, '36, p. 337).

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Trap at (Gesner, '36, pp. 211–213).

View of (Jackson and Alger, '33, pl. 2).

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Mention of trap dikes near (Macfarlane, '79, p. 107).

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Carthage, N. C. Boundary of Newark area near (Emmons, '52, p. 119).

Carthage, N. C.—Continued.

Thickness of the Newark at (Emmons, '56, p. 231).

Carversville, Pa. Trap dikes near (Lewis, '85, p. 453).

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Center Bridge, Pa. Character of strata near (H. D. Rogers, '58, vol. 2, p. 673).

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Center Ridge, N. J. Building stone near (Cook, '68, pp. 511–512).

Coarse sandstone near (H. D. Rogers, '36, p. 155).

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Thickness of strata at (Cook, '68, p. 201).

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Trap dikes near (Lewis, '85, p. 454).

Center valley, Pa. Dip and character of rocks near (C. E. Hall, '83, p. 232, 233).

Centerville, N. J. Boundary of trap outcrop at (Cook, '68, p. 177).

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Centerville, Pa. Description of trap dike near (Frazer, '80, p. 30).

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In New York Acad. Sci., Trans., vol. 2, 1882-1883, pp. 88-90.

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In New York Acad. Sci., Trans., vol. 5, 1885-1886, pp. 228-230.

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In Meriden Sci. Assoc., Proc. and Trans., vol. 2, 1885-1886, pp. 23-28.

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In Meriden Sci. Assoc., Proc. and Trans., vol. 2, 1885-1886, p. 29.

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In Meriden Sci. Assoc., Trans., vol. 4, 1889, 1890, pp. 58-61.

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In Meriden Sci. Assoc., Trans., vol. 4, 1889-1890, p. 62.

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CHAPIN, J. H. Fossil plants collected by, at Durham, Conn. (Newberry, '88, p. 92).

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In Canadian Jour., n. s., vol. 1, pp. 39-48.

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On the occurrence of copper ore in the island of Grand Manan, bay of Fundy.

In Canadian Jour., n. s., vol. 13, pp. 234-239, pl. op. p. 183.

Describes the position and topography of the island, its geological features, and the occurrence of copper ore. The section shows the supposed relation of Newark and older rocks.

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Toronto, 12°, pp. i-xxii, 33-104, pl, 1-5, and 6 maps.

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Charlestown, Pa. Newark rocks at (Frazer, '83, p. 226.)

Charlestown mines, Pa. Boundary of Newark near (Lesley, '83, p. 196).

Charlotte and Reid's bridge, Va. Section between (W. B. Rogers, '39, pp. 79-80).

- **Charlottetown, P. E. I.** Dip at (Dawson and Harrington, '71, p. 16).
- **CHATARD.** Analysis of iron ore by (Kerr, '75, p. 232).
- **Chatham, Conn.** Brief account of building stone found at (E. Hitchcock, '35, pp. 46, 215).
  - Coal reported at (E. Hitchcock, '23, vol. 6, p. 63).
  - Description of fossil footprints from (E. Hitchcock, '41, pp. 478–501).
  - Early discovery of fossil footprints at (E. Hitchcock, '36, p. 309).
  - Localities of fossil footprints in (E. Hitchcock, '41, p. 467).
  - Mention of sandstone quarries near (Percival, '42, p. 449).
  - Notice of building stone at (E. Hitchcock, '32, p. 35).
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- **Chatham, N. C.** Account of the Newark near (Mitchell, '42, pp. 130–134).
  - Analysis of coal from (Battle, '86).
  - Anthracite near trap (Genth and Kerr, '81).
  - Belodon piscus from (Cope, '75, pp. 34, 35).
- **Chatham, N. J.** Boring for coal at (Cook, '68, p. 696).
  - Character of the country east of (H. D. Rogers, '40, p. 134).
  - Dip near (H. D. Rogers, '40, p. 133).
  - Tory Hill near, described (Cook, '68, pp. 186–187).
  - Metamorphosed shale near (H. D. Rogers, '40, pp. 132–133).
  - Trap ridge near (Cook, '82, p. 56).
- **Chatham, Pa.** Trap dike near (Lewis, '85, p. 447).
- **Chatham series, N. C.** Age of, as indicated by reptilian remains (Emmons, '57, pp. 92–93).
  - Age of, as shown by fossil fishes (Emmons, '57, p. 54).
  - Brief account of (Emmons, '57, pp. 10–11, 19–20. Emmons, '58).
  - Conglomerate at base of (Emmons, '57, p. 11).
  - Reexamination of certain mammalian jaws from (Osborn, '86).
  - Reference to the age of (Marcou, '88, p. 30).
  - Reptiles of (Emmons, '57, pp. 54–93).
  - Thickness of (Emmons, '57, p. 30).
- **Chauncy Peak, Conn.** Description of trap ridges near (Davis and Whittle, '89, p. 115).
  - Detailed study of the geological structure near (W. M. Davis, '89).
  - Small map of portion of (Davis and Whittle, '89, pl. 2).
  - Trap ridges near (Davis and Whittle, '89, pp. 107–108).
- **Chelsea, N. Y.** Description of trap rock at (Britton, '81, p. 169).
- **Cherry hill, Conn.** Strike and dip of sandstone near (Hovey, '89, pp. 372–373, 379).
- **Cherryville, N. J.** Trap outcrop near (Cook, '82, p. 63).
- **Cheshire, Conn.** Character of the trap ridges near (W. M. Davis, '89*b*, p. 25).
  - Copper mines of (Percival, '42, p. 318).
- **Cheshire, Conn.—Continued.**
  - Decomposed rocks in (Percival, '42, pp. 436, 437).
  - Description of trap ridges in (Percival, '42, p. 403).
  - Trap dikes in (Percival, '42, p. 320).
- **Cheshire station, Conn.** An account of trap ridges near (Davis and Whittle, '89, pp. 105–106).
- **Chester, Pa.** Catalogue of specimens of trap, etc., from near (Frazer, '77, pp. 332–381).
- **Chester, S. C.** Description of trap dikes near (Tuomey, '44, p. 12).
- **Chester county, Pa.** Brief report on (Lesley, '85, pp. xxxvi–xxxvii).
  - Description of Warwick iron mine (H. D. Rogers, '58, vol. 2, p. 708).
  - Geology of (Lesley, '83).
  - Map of mining district of (H. D. Rogers, '58, vol. 2. op. p. 674).
  - Mention of lead and copper ores of (Lyell, '54, p. 13).
  - Newark rocks of (Frazer, '83).
- **Chester county, S. C.** Trap dikes in (Hammond, '84, pp. 466–497).
- **Chester county, Va.** Discussion of the age of the coal-bearing rocks of (Marcou, '58, pp. 14–15).
- **Chester court-house, S. C.** Analysis of trappean soil from (Hammond, '84, p. 497).
- **Chesterfield, Va.** Account of coal mines in (Grammar, '18. Taylor, '35, pp. 281–286).
  - Account of coke in, with analysis (W. B. Rogers, '40, p. 124).
  - Analysis of coal from (W. R. Johnson, '51, p. 12).
  - Test of coal from (Emmons, '56, p. 249).
- **Chesterfield coal mine, Va.** Brief account of (Macfarlane, '77, p. 507).
- **Chesterfield county, S. C.** Account of the geology of (Lieber, '56, pp. 19, 20, 103, 106, pl. 6).
  - Brief account of contact metamorphism in (Tuomey, '48, p. 68).
- **Chesterfield county, Va.** An account of a visit to the coal mines of (Lyell, '49, pp. 279–288).
  - Character and efficiency of coal from (W. R. Johnson, '50, pp. 133, 134, and table op. p. 134).
  - Description and analysis of natural coke from near (Raymond, '83).
  - Description of rocks in (W. B. Rogers, '43, p. 298).
  - Description of the Newark in (W. B. Rogers, '40, pp. 71–72).
  - Detailed account of coal in (W. B. Rogers, '36, pp. 52–61).
  - Fossils collected in (Marcou, '49, pp. 273–279).
  - List of fossil fishes from (De Kay, '42).
  - Output of coal for 1886 (Ashburner, '87, p. 554).
  - Production of coal from, in 1880 (Prime, '86, pp. 670–673).
  - Trial of the coal of, for heating purposes (W. R. Johnson, '44, pp. 349–362, 378–389–448).

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[Analyses of Newark sandstone from near Hancock, Md.]

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Cited on the extent of the Dan river area, N. C. (Olmstead, '27, p. 128).

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Clements, N. S. Iron ores at (Alger, '27, pp. 229, 330).

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Reviewed by F. H. Newell in Geol. Mag., dec. 3, vol. 6, 1889, pp. 138–140.

Discusses briefly the mode of formation and the age of the Richmond coal field. Presents a historical sketch of coal-mining, and indicates what is to be expected from

CLIFFORD, WILLIAM—Continued.

the mines in the future. Analyses of coal and of natural coke are given on p. 10. A map of the entire field is given on pl. 1, and plats and sections of the mines at Clover hill, Midlothian, Black heath, and Deep run on pls. 2-5.

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Description of sandstone outcrops near (H. D. Rogers, '36, p. 153).

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Detailed description of calcareous conglomerate near (H. D. Rogers, '40, pp. 139-140).

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Trap outcrop near (Darton, '90, p. 70).

Unconformity at base of the Newark near (Darton, '90, p. 15).

Clinton valley, N. J. Dip along the Delaware adjacent to limestone area near (Nason, '89, p. 18).

Closter, N. J. Altered shale near (Cook, '83, p. 24).

Columnar trap at (Akerly, '20, p. 33).

Indurated shale near (Darton, '90, p. 51).

Sandstone on west slope of Palisades at (Cook, '68, p. 208).

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Section of Palisades near (Cook, '68, p. 200).

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Clover Hill, Va.—Continued.

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Discovery of (Olmstead, '20. Olmstead, '24, p. 19).

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Value of, for gas-making (Jackson, '56*a*, pp. 31-32).

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  - Discussion of the probability of finding (E. Hitchcock, '35, pp. 53–54).
  - Mention of (E. Hitchcock, '23, vol. 6, p. 63. Percival, '42, pp. 442, 452).
- **Coal in Maryland.** A search for (Ducatel, '37, pp. 36–37).
- **Coal in Massachusetts.** Analysis of (E. Hitchcock, '41, p. 141).
  - Brief account of (E. Hitchcock, '41, p. 448).
  - Discussion concerning (E. Hitchcock, '35, pp. 229–232. E. Hitchcock, '41, pp. 138–142).
- **Coal in New Jersey.** At Bellville (Cook, '81, p. 46).
  - Localities of, brief mention (Cook, '68, p. 174).
  - Mention of (Cook, '68, p. 696).
  - Near Bernardsville (Nason, '89, p. 28).
  - Near Boonton and Newark (Cook, '78, p. 110).
  - Near Morristown) Nason, '89, p. 28).
  - Near Trenton (Nason, '89, p. 27).
  - Near Passaic (Pierce, '20, p. 194).
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  - Brief reference to (Frazer, '80, p. 44).
  - Notice of (Frazer, '85, p. 403).
  - Reported (Lesley, '91).
- **Coal in Virginia.** Account of (Heinrich, '78, pp. 243, 244. Lyell, '54, p. 12).
  - Account of the mining of (Grammar, '18. Taylor, '35, p. 281–286).
  - Age of (Marcou, '55, pp. 872, 873).
  - Amount produced (Daddow and Bannan, '66, pp. 401, 402. Hotchkiss, '82. Taylor, '48, pp. 51, 52. Wooldridge, '42).
    - In 1880 (Prime, '86, pp. 670–673).
    - In 1883 and 1884 (Williams, '85, pp. 97, 98).
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  - Analysis of (Chance, '85, p. 19. Clifford, '87, pp. 9, 10. De La Beche, '48, p. LXV. Heinrich, '78. W. R. Johnson, '50, p. 176. Macfarlane, '77, p. 515. Silliman and Hubbard, '42. Williams, '83, p. 82).
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  - Economic value of (Hotchkiss, '80).
  - Experiments on the heating qualities of (W. R. Johnson, '44).
  - Gas obtained from (Emmons, '57, p. 31).
  - In local basins (Lyell, '47, p. 266).
  - Mention of (Clemson, '35. Credner, '66).
  - Mode of occurrence (Heinrich, '78, pp. 266–274. Lyell, '49, p. 284).
  - Near Leaksville (W. B. Rogers, '39, p. 78).
  - Organic structure of (Lyell, '47, p. 268).
  - Position of (Lyell, '47, p. 262).
  - Price of (Taylor, '48, pp. 50–51).
  - Quality of (Taylor, '35, pp. 283–286).
  - Specimens of, for the New Orleans Exposition (Hotchkiss, '84).
  - Structure (Newell, '89).

- **Coal in Virginia**—Continued.
  - Thickness of (Fontaine, '83, pp. 7, 8, 9. Grammar, '18, pp. 126–127. Lyell, '47, pp. 263–264, 265, 267, 271. Newell, '89. W. B. Rogers, '36, pp. 53–60. W. B. Rogers, '43*b*, p. 532. W. B. Rogers, '43, p. 298. Wooldridge, '42).
  - Thinning of (Clifford, '88).
  - Trials of, for heating purposes (W. R. Johnson, '44, pp. 308–451).
  - Map showing production of, in 1880 (Prime, '86, pl. 41).
- **Coalbrookdale, Va.** Analysis of coal from (Clifford, '87, p. 10).
- **Coalfield station, Va.** Boundary of Newark area near (Heinrich, '78, p. 230).
- **Cobequid bay, N. S.** Description of Newark rocks near (Dawson, '47, pp. 51, 52).
  - Description of north side of (Dawson, '78, pp. 99).
  - Discussion of the geology near (Dawson, '78, p. 110).
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  - Newark outcrops near (Chapman, '78, p. 112).
  - Section from, to Cobequid mountains (Dawson, '78, pl. op. p. 125).
- **Cocalico, Pa.** Dip at (Frazer, '80, p. 43).
- **Coke, Natural.** Analysis of North Carolina specimens (Battle, '86).
  - Brief account of (Tuomey, '48, pp. 103–104. Wilkes, '58, p. 7).
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  - Discussion of the character and composition of (W. R. Johnson, '50, pp. 155, 156).
  - Discussion of the origin of (Hotchkiss, '83. Stevens, '73. Wurtz, '75).
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  - Thickness of (W. B. Rogers, '54, p. 55*a*).
- **Cold Point, Pa.** Boundaries of the Newark in (C. E. Hall, '81, pp. 72, 73, 75).
- **Cole iron mine, N. C.** Brief account of, with sketch (Willis, '86, p. 306).

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Contact metamorphism at (H. D. Rogers, '58, vol. 2, p. 687).
Description of (Gibson, '20).
Description of trap dikes near (H. D. Rogers, '58, vol. 2, p. 687).
Trap of the (H. D. Rogers, '39, p. 22).

Conglomerate at the base of the Newark system (Emmons, '57, pp. 19–21).
Discussion of the glacial origin of (J. D. Dana, '90).

Conglomerate in Connecticut. Description of (Percival, '42, pp. 316, 324. Percival, '42, p. 427. W. M. Davis, '89. W. M. Davis, '89. Hovey, '89, pp. 372–375).

Conglomerate in Connecticut valley. Account of (E. Hitchcock, '35, pp. 214, 215, 416. E. Hitchcock, '23, vol. 6, p. 62).
Composition of (E. Hitchcock, '58, p. 22).
Description of (E. Hitchcock, '35, pp. 243–251. E. Hitchcock, '47*a*, pp. 199–207).
Distribution of (E. Hitchcock, '58, p. 11. Jones, '62, p. 91. Percival, '42, pp. 447, 449. Russell, '78, p. 231. Shaler and Davis, '81, pp. 95–96).

Conglomerate in Maryland. Brief account of (Ducatel, '37, pp. 36–37. Ducatel, '40. Tyson, '60, appendix, p. 3. H. D. Rogers, '36, pp. 146–147. Fontaine, '79, p. 32).

Conglomerate in Massachusetts (E. Hitchcock, '55, p. 226. C. H. Hitchcock, '77*a*, p. 446).
Description of (E. Hitchcock, '41, pp. 441, 442, 526, 527, 648. Emmons, '57, pp. 5, 6, 7. E. Hitchcock, '41, p. 527. Nash, '27, p. 246).

Conglomerate in New Brunswick (Gesner, '40, p. 18. Matthew, '65, pp. 123, 124, 125).
Origin of, and character (Whittle, '91).

Conglomerate in New Jersey. Age of (Nason, '89, p. 41).

Conglomerate in New Jersey—Continued.
At Boonton, reference to (Russell, '78, p. 232).
At Paterson (Cook, '79, p. 18).
At Pattenburg (Cook, '82, p. 17).
At Pompton, reference to (Russell, '78, p. 232).
Beneath First mountain (Cook, '68, p. 337).
Beneath the Palisades (Cook, '68, p. 208. Darton, '90, p. 50).
Brief account of (Emmons, '57, p. 8. Cook, '65, p. 7. Nason, '89, pp. 16, 17).
Cemented with trap sand (Nason, '89, p. 21).
Change of, to sandstone (Cook, '82, p. 33).
Character and distribution of (Nason, '89, pp. 20–21, 39–41. Russell, '78, pp. 231–241. Cook, '68, pp. 391, 392, 393. Russell, '80*a*).
Containing trap pebbles, origin of (Nason, '89*a*).
Description of (Cook, '82, pp. 21–22).
Details of (Cook, '68, pp. 209–212).
Detailed description of (H. D. Rogers, '36, pp. 146–150. H. D. Rogers, '40, pp. 135–141).
Dip of (Cook, '79, pp. 29, 30).
Lithological description of (Cook, '68, p. 206).
Localities of (Cook, 82, p. 21).
Mode of formation of (Russell, '78, pp. 232–237).
Mention of (Cook, '68, p. 210. Cook, '79, p. 39. Cook, '82, pp. 18, 19. Cook, '82, pp. 39–42. Nason, '90).
Near Passaic falls (Cook, '79, p. 18).
Near Paterson (Cook, '82, p. 51).
Near Pompton, description of (Kitchell, '56, pp. 144, 145).
Near Trenton, brief account of (H. D. Rogers, '40, pp. 119, 120).
On west border of Newark (Cook, '79, pp. 18–19).
Origin of (Russell, '78, p. 253).
Origin of (Cook, '68, pp. 337–338).
Summary of conclusions in reference to origin of (Cook, '89, p. 15).
Two varieties of (Cook, '82, p. 21).

Conglomerate in New York. Brief account of (Mather, '39, pp. 123–125, 126–127. Mather, '43, pp. 286, 287, 288, 289).
W. W. Mather cited on (Lea, '53, p. 190).

Conglomerate in North Carolina. Brief account of (Emmons, '56, pp. 229–230. Emmons, '57, pp. 97–98. Emmons, '57, pp. 77. Kerr, '75, pp. 141, 303. Kerr, '75*a*).
Dan river coal field, brief account of (Emmons, '52, p. 147. Emmons, '56, p. 256).
Deep river coal field (Emmons, '52, p. 121. Emmons, '56, pp. 237–238. Macfarlane, '77, pp. 518–519).
Brief account of (Wilkes, '58, pp. 4–5. W. R. Johnson, '51, p. 5).
Source of (Kerr, '75, p. 146).

Conglomerate in Nova Scotia (Dawson, '78, p. 87. Dawson, '78, pp. 100–101. Ells, '85, p. 7E).

Conglomerate in Pennsylvania. A general account of (Lea, '51).
At base of the Newark (Lesley, '83, pp. 184, 188).
At top of the Newark (Lesley, '83, p. 188).
Brief account of (H. D. Rogers, '41, pp. 17, 38–39. H. D. Rogers, '58, vol. 2, pp. 677, 679, 680).

Conglomerate in Pennsylvania—Continued.
Character of the (Lesley, '83, p. 184).
Derived from the Potsdam (Lesley, '83, p. 189).
Description of (H. D. Rogers, '58, vol. 2, pp. 669, 670, 679, 681-684).
In Adams county, brief account of (Frazer, '77, pp. 265-266).
In Berks county, brief account of (d'Invilliers, '83, pp. 199, 201-203).
In Berks county, observations on (d'Invilliers, '83, pp. 213-226).
In Bucks county, brief account of (Lesley, '85, p. xxix).
In Chester county (Frazer, '83, p. 244. Lesley, '83, pp. 184, 192).
In Chester county, on gneiss (Lesley, '83, pp. 188, 189).
In Chester and Bucks counties, brief account of (C. E. Hall, '81, p. 24).
In Montgomery county, brief account of (C. E. Hall, '81, p. 24).
In Shelley's ore band near Dillsburg (Frazer, '77, p. 222).
In the Warwick shaft (d'Invilliers, '83, pp. 317, 318, 320).
In York county (Frazer, '85, p. 403).
Localities of (H. D. Rogers, '39, p. 17).
Mode of deposition of (Lesley, '83, pp. 179-180).
Name applied to (H. D. Rogers, '58, vol. 2, p. 679).
Near Dillsburg (Frazer, '77, p. 225).
Near Falmouth and Collins, detailed account of (Frazer, '80, pp. 103-104).
Near Fairville, brief account of (Frazer, '80, p. 49).
Near Monroe, dip of (C. E. Hall, '83, p. 247).
Near Morrisville, from analysis of (C. E. Hall, '81, pp. 24, 111).
Near Yardleyville (H. D. Rogers, '58, vol. 2, p. 672).
Near York, dip of (Frazer, '76, p. 92).
On northwest border of the Newark system (H. D. Rogers, '58, vol. 2, p. 674).
With iron ore (d'Invilliers, '83, p. 239).

Conglomerate in Virginia. Brief account of (W. B. Rogers, '36, pp. 81, 82. W. B. Rogers, '37, p. 7).
Character and distribution of (W. B. Rogers, '39, pp. 70, 72).
Description of (Cornelius, '18, p. 216. Heinrich, '78, pp. 239-240. Heinrich, '78, pp. 252, 256. W. B. Rogers, '39, p. 80. W. B. Rogers, '40, pp. 60-61).
Near Leesburg and Culpeper Court House, description of (Fontaine, '79, pp. 32, 34).
"Potomac marble," W. B. Rogers cited on the origin of (Lea, '53, p. 180).

Conglomerate on Prince Edwards island (Dawson, '78, p. 87).

CONLAN, P. H., and J. Records of wells bored by, in New Jersey (Nason, '89*b*).

Connecticut. Age of Newark system in, note in reference to (Dawson, '58).
Age of the Newark of, remarks on (Newberry, '85).

Connecticut—Continued.
Analysis of diabatite from Farmington hills (Hawes, '75*a*).
Analysis of trap from West Rock (Frazer, '75*a*, p. 404).
Bones, fossil, at East Windsor, note on the finding of (N. Smith, '20).
Crescent form of certain trap ridges in (H. D. Rogers, '43*c*).
Critical study of trap outcrops near New Haven (J. D. Dana, '91).
Dip in, remarks on (E. Hitchcock, '41, p. 448).
Fish, fossil, from, a study of (J. H. Redfield, '36).
Fishes, fossil, from, description of (Newberry, '78). W. C. Redfield, '41).
Fishes, fossil, from, list of (De Kay, '42).
Fishes, fossil, from, remarks on (Harlan, '34, pp. 92-94).
Footprints in, notice of the discovery of (W. C. Redfield, '42).
Footprints from, report on (Rogers, Vanuxem, Taylor, Emmons, and Conrad, '41).
Fossil bones found at East Windsor (John Hall, '21).
Fossil bones found in, account of (E. Hitchcock, '41, pp. 503-504, pl. 49).
Fossils found at Middletown, brief reference to (Silliman, '37).
Geology about Meriden (C. H. S. Davis, '70).
Geology of, report on (Percival, '42. Shepard, '37).
Geology of Berlin, brief references to (Percival, '22).
Geology of the region about New Haven (Silliman, '14).
Hanging hills, description of (Chapin, '87).
Hanging hills of Meriden, excursion to (J. D. Dana, '70).
Lost volcanoes of (W. M. Davis, '91).
Newark areas in (Percival, '42, p. 10).
Newark system in, brief account of (Lyell, '54).
Newark system of, former extent of (Britton, '81, p. 169. D. S. Martin, '85).
Sandstone from (J. D. Dana, '71*b*).
Sandstone quarries of (S. P. Merrill, '89, pp. 446-448. Shaler, '84, pp. 126, 127).
Sandstone strata at Portland, spontaneous movements in (J. Johnson, '54).
Sections, Beckley (W. M. Davis, '83, pp. 305-307, pl. 10).
Sections, Bristol copper mine (Silliman and Whitney, '55).
Sections, East Haven, dikes in. After E. Hitchcock (W. M. Davis, '83, p. 280, pl. 9).
Sections, Lamentation mountain (W. M. Davis, '89, pl. 1).
Sections, Meriden, near (W. M. Davis, '89, pl. 5).
Sections, Meriden district (W. M. Davis, '89*c*, p. 425).
Sections, Meriden-New Britain district (W. M. Davis, '89, pl. 5).
Sections, New Haven and East Haven, between (W. M. Davis, '83, pp. 305-307, pl. 10).

Connecticut—Continued.
  Sections, South Britain, showing supposed relation of trap ridges near (W. M. Davis, '88, p. 471).
  Sections, Springfield, Connecticut valley (E. Hitchcock, '58, pl. 2).
  Sections through (Walling, '78, pl. op. p. 192).
  Sections, Wallingford, across a number of ridges in. After A. B. Chapin (W. M. Davis, '83, p. 280, pl. 9).
  Southbury area, description of (Silliman, 20*a*, pp. 231-233).
  Thickness of Newark rocks in (J. D. Dana, '73, vol. 5, p. 427).
  Trap dikes at East Haven, account of (E. Hitchcock, '41, pp. 655-656).
  Trap dikes at Wallingford (Chapin, '35).
  Trap dikes in, note on (Lyell, '47, p. 273).
  Trap from West Rock, analysis of (Frazer, '75*a*, p. 409).
  Trap of, compared with trap from Gettysburg, Pa. (Frazer, '75*b*).
  Trap ridges in (J. D. Dana, '73, vol. 6, pp. 105, 106).
  Trap rock of, character of (J. D. Dana, '72).
  Trap rock of, detailed description of (Percival, '42, pp. 299-426).
  Trap rock of, origin of (J. D. Dana, '71*a*).
  Trap rock of, quarries of (Shaler, '84, p. 127).
  Trap sheets of, described (Davis and Whittle, '89).
  Trap sheets of, extrusive, with breccia in (Rice, '86).
  Tree trunks at Bristol, description of the finding of (Silliman, jr., '47).
  Unconformity at base of Newark in (J. D. Dana, '73, vol. 5, p. 427).
  Vertebrate fossils (bones) from, description of (Cope, '69, p. 122. Marsh, '89, pp. 331, 332. Wyman, '55. Wyman, 55*a*).
  Vertebrate fossils, notice of (Silliman, '20).
  Vertebrate fossils, remarks on (Newberry, '85, W. B. Rogers, '60*a*).
  West Rock, description of (Silliman, '20*a*, pp. 202-203).
Connecticut river. Deflection of, at Middletown (W. M. Davis, '89*c*, p. 432).
  (See, also, Connecticut valley.)
Connecticut valley. Account of the Newark system in (E. Hitchcock, '35, pp. 211-251).
  Age and divisions of the stratified rocks in (Wells, '50).
  Age of Newark rocks of (Emmons, '57*b*, p. 79-80).
  Age of Newark system in (W. C. Redfield, '51).
  Age of sandstone in (E. Hitchcock, '58, p. 3. Jackson, '50).
  Age of sandstone of, remarks on (H. D. Rogers, 43*b*).
  Age of sandstone of, statement of opinion concerning (C. H. Hitchcock, '55, p. 392).
  Age of the red sandstone in, discussed (H. D. Rogers, '58, vol. 2, pp. 694-695).
  Age of sandstone of, statement of opinion concerning (C. H. Hitchcock, '55, p. 392).
  Age of, as indicated by fossil fishes (W. C. Redfield, '56, pp. 180-181).
Connecticut valley—Continued.
  Age of, as indicated by stratigraphy (Foster, '51).
  Amount of erosion in (Hubbard, '50, p. 170).
  Analyses of coprolites from (S. L. Dana and E. Hitchcock, '45).
  Analysis of trap rocks from (Hawes, '75).
  Brief account of (Danberry, '39, pp. 19-23. E. Hitchcock, '36, pp. 329-330. H. Hitchcock, '56. Lyell, '71, pp. 361. Russell, '78, pp. 221-222).
  Brief sketch of Newark in (H. D. Rogers, '58, vol. 2, pp. 759-765).
  Building stone from (Alger, '51. Lyell, '54, p. 13).
  Coal in, probability of finding (E. Hitchcock, '35, pp. 53-54).
  Coal in, reference to (Silliman, '27).
  Conglomerate in, distribution (Russell, '78, p. 238).
  Conglomerate in, glacial origin of (Shaler and Davis, '81, pp. 95-96).
  Conglomerate of trap in (E. Hitchcock, '44*e*, pp. 6-8).
  Copper associated with trap, discussion of the origin of (Silliman and Houghton, '44).
  Copper mine at Bristol, description of (Silliman and Whitney, '55).
  Copper near Wallingford, discovery of (Silliman, '18).
  Description of (E. Hitchcock, '41, pp. 256-259).
  Description of Newark of (Lyell, '66, pp. 452-456).
  Dip in (J. D. Dana, '75, p. 419. E. Hitchcock, '36, p. 329. E. Hitchcock, '47*a*, p. 200).
  Dip in, hypothesis accounting for (Bradley, '76).
  Dip in, origin of (Whitney, '60).
  Dip in, brief account of (E. Hitchcock, '35, p. 224).
  Dip of limestone in (E. Hitchcock, '58, p. 8).
  Dip of red sandstone in, brief account of (H. D. Rogers, '58, vol. 2, pp. 761-762).
  Dip of rocks in (E. Hitchcock, '58, pp. 10, 11).
  Dip of rocks of, origin of (Silliman, jr., '42*a*).
  Dip of sandstones and shales, origin of (Russell. '78, p. 229).
  Dip of sandstone in, cause of (Silliman, jr., '42).
  Dip of sandstones of, accounted for by mode of deposition (Silliman, jr., '44).
  Drainage of the Newark area of (J. D. Dana, '75, p. 500).
  Extent of the Newark in (A. Smith, '32, pp. 219-220).
  Fishes, fossil, from, description of (E. Hitchcock, '37, pp. 267-271).
Connecticut valley, footprints from. Additional observations on (E. Hitchcock, '63).
  Annelid trails from (E. Hitchcock, '58, pp. 160-166, pls. 26, 27, 28, 49).
  Association of, with trap (E. Hitchcock, '58, p. 173).
  Brief account of (Emmons, '57, pp. 139-142. E. Hitchcock, '37, pp. 267, 271. E. Hitchcock, '55*a*, pp. 181-189. Hitchcock and

Connecticut valley, footprints from—Continued.
Hitchcock, '67. pp. 309–320. Lyell, '43, pp. 39–40).
Brief discussion of (Owen, '43).
Brief reference to the finding of (Anonymous, '38*a*).
Characteristics and paleontological value of (E. Hitchcock, '60).
Description of (Deane, '43. Deane, '45*a*. Deane, '45*d*. E. Hitchcock, '36. E. Hitchcock, '48. E. Hitchcock, '58. E. Hitchcock, '65).
Descriptions and figures of (Deane, '49).
Descriptions and illustration of (E. Hitchcock, '58).
Letter from R. I. Murchison concerning (Murchison, '43*a*).
List of (E. Hitchcock, '37*a*).
Localities in, additional (E. Hitchcock, '37*b*).
Localities of (D. Marsh, '48).
Marsh cited on the reptilian character of (Hull, '87, p. 86).
Note on (Silliman and Dana, '47).
Observations regarding (Mantell, '43).
Of crustaceans (Dana, '58*a*).
Popular description of (E. Hitchcock, '58, pp. 175–190.
Priority in the discovery of (Bouvé, '59. Deane, '44. Deane, '44*b*. E. Hitchcock, 44*d*. E. Hitchcock, '58, pp. 191–199. Mackie, '64. W. B. Rogers, '59).
Remarks on (Cope, '69, p. 242. Deane, '42. Field, '60*a*. E. Hitchcock, '45*c*. Leidy, '58. Warren, '55).
Revised classification of (Hitchcock, '45).
Synopsis of (E. Hitchcock, '58, p. 174).
Table showing characteristics of (E. Hitchcock, '58, pp. 201–205).
Wide distribution of (Lea, '53, pp. 185–188).

Connecticut valley. Former connection of the Newark system in, with the rocks of the same age in New Jersey (Bradley, '76, p. 289).
Former extent of the Newark rocks of (J. D. Dana, '79. D. S. Martin, '83. Russell, '80*a*).
Former extent of the sandstones in (W. M. Davis, '82*a*).
Fossil fish localities at Middlefield and Westfield, described (Anonymous, '38).
Fossil fish from, remarks on (Emmons, '57, p. 142).
Fossil fishes from (E. Hitchcock, '58, pp. 144–147, pls. 25, 26. Newberry, '88).
Fossil fishes from, description of (Edgerton, '49).
Fossil fishes from Little Falls (C. H. S. Davis, '87).
Garnets in trap near New Haven (E. S. Dana, '77).
General account of the geology of (E. Hitchcock, '23. E. Hitchcock, '41, pp. 434–441. Silliman, '24, pp. 17–30, 428–431).
Joints in, remarks on (E. Hitchcock, '41*a*. Silliman, jr., '41).
Lithological character of sandstone of (E. Hitchcock, '36, p. 330).

Connecticut valley—Continued.
Lithology and stratigraphy of, brief account of (Wells, '51*a*).
Map of Newark area in (W. M. Davis, '89, pl. 1).
Map of, showing footprint localities (E. Hitchcock, '58, pl. 2).
Meriden, detailed study of structure near (W. M. Davis, '89).
Microscopical examination of sandstone from (Hawes, '78).
Mineralogical composition and durability of building stone from near East Haven (Hubbard, '85).
Mode of deposition of sandstone of (E. Hitchcock, '58, p. 172–173).
Mode of formation of Newark rocks in (A. Smith, '32, pp. 221–224).
Mode of formation of the Newark sandstones and shales of (Jackson, '41).
Origin and former extent of the Newark rocks of, discussed (J. D. Dana, '83).
Plants, fossil, from (Chapin, '87*a*. J. D. Dana, '55. E. Hitchcock, '43*b*, p. 294. E. Hitchcock, '58, p. 8. E. Hitchcock, jr., '55. Leidy, '58. Newberry, '88).
Raindrop impressions from (Deane, '42).
[Ripplemarks from] (E. Hitchcock, '56, p. 111).
Sections (Eaton, '20, pl. 2. Le Conte, '82, pp. 245, 246).
Section after E. Hitchcock, A. Eaton, A. Smith, and A. B. Chapin (W. M. Davis, '83, pp. 280–281, pl. 9).
Section, hypothetical (W. M. Davis, '86, p. 350).
Section, hypothetical, after J. Le Conte (W. M. Davis, '83, p. 281, pl. 9).
Section, Mettawampe, Mass. (E. Hitchcock, '58, pl. 3).
Section, Mount Tom, Mass. (E. Hitchcock, '58, pl. 3).
Section, Nowottuck, Mass. (E. Hitchcock, '58, pl. 3).
Section, Springfield, Conn. (E. Hitchcock, '58, pl. 2).
Section, Turner Falls, Mass. (E. Hitchcock, '58, pl. 3).
Structure of (Davis and Loper, '91).
Structure of, discussed (W. M. Davis, '88. W. M. Davis, '88*a*. W. M. Davis, '89*b*. Le Conte, '82, pp. 245, 246).
Tadpole nests, so called, discussion of (Shepard, '67).
Thickness of strata in (E. Hitchcock, '53. E. Hitchcock, '58, pp. 11–15. Smith, '32, pp. 219–220).
Topographical developments of the Newark system in (W. M. Davis, '89. E. Hitchcock, '41, pp. 446–447).
Topography of (E. Hitchcock, '35, pp. 220–222).
Topography of the region about New Haven (J. D. Dana, '71, pp. 46–47. J. D. Dana, '75*a*, p. 170).
Trap and trap conglomerate in, brief description of (E. Hitchcock, '44*e*, pp. 6–8).
Trap hills of, origin of, discussed (Chapin, '87).

Connecticut valley—Continued.

Trap of (Chapin, '87).

Trap of, an account of (A. Smith, '32, pp. 224–227).

Trap of, in connection with the transmission of vibrations (Stodder, '57).

Trap ridges in, crescent-shaped (Silliman, '44).

Trap ridges in the East Haven-Bradford region (Hovey, '89).

Trap ridges of, brief account of (Russell, '78. pp. 241–242).

Trap ridges of, observations on (W. M. Davis, '82).

Trap ridges of, reference to (J. D. Dana, '47, pp. 391–392).

Trap rock of (E. S. Dana, '75).

Trap rocks in, brief account of (Emmons, '57, p. 151. Porter, '22).

Trap rocks in, brief account of distribution of (Percival, '42, pp. 10–11).

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Trap rocks of, described (E. Hitchcock, '47*a*, p. 199–207).

Trap rocks of, reference to the volcanic origin of (Cooper, '22, 239–243).

Trap sheets of (W. M. Davis, '82*a*).

Trap tufa or volcanic grit of (E. Hitchcock, '44).

Uplift of the sandstone in (J. D. Dana, '73, vol. 5, p. 432).

Unconformity at base of the Newark in (Jackson, '56*b*, p. 184).

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See also Massachusetts and Connecticut.

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Gives a figure of *Myacites pennsylvanicus*, previously described by T. A. Conrad, pl. 1. [The plate referred to is numbered 7 by mistake.]

Conshohocken, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 22).

Description of trap dikes near (C. E. Hall, '81, p. 19).

Trap dikes near (C. E. Hall, '81, pp. 19–20, 75. Lewis, '85, p. 443. H. D. Rogers, '58, vol. 1, p. 214).

Contact of Newark rocks and gneiss in New Jersey (H. D. Rogers. '40, pp. 16, 17, 18).

Of Newark and Lower Carboniferous near Folly River, Nova Scotia (Ells, '85, p. 48E).

Of trap and sandstone at Martin Dock (Cook, '82, p. 58).

Of trap and sedimentary rocks in New Jersey (Cook, '83, pp. 164–165).

Of trap with sedimentary rocks in New Brunswick (Bailey, '72, pp. 220–221).

Phenomena at Alpine, New Jersey (Cook, '82, p. 46).

Phenomena in N. J. (Cook, '82, pp. 37, 50, 93).

See also metamorphism contact.

COOK, GEORGE H. **1864.**

Report of Prof. George H. Cook upon the geological survey of New Jersey and its progress during the year 1863.

Trenton, N. J. Pp. 1-13.

Contains a brief notice of extent of Newark rocks in Hunterdon county, together with an account of prevailing dips, and a qualified statement of the age of the Newark system in New Jersey. Pp. 6-7.

COOK, GEORGE H. **1865.**

The annual report of Prof. George H. Cook, state geologist, to his excellency Joel Parker, president of the board of managers of the Geological Survey of New Jersey, for the year 1864.

Trenton, N. J. Pp. 1-24, pl. 2.

East border of the Newark system in New Jersey defined, p. 5. Northwest border defined, pp. 6-8. Geological map, p. 21. Geological section, p. 22. Tabular statement to accompany geological map, giving principal rocks and localities where found, p. 24.

COOK, GEORGE H. **1868.**

Geology of New Jersey.

Newark [N. J.]. Pp. i-xxiv, 1-900, pl. 6. Accompanied by a portfolio containing 8 maps in 13 sheets.

The following table indicates the contents of this volume so far as it relates to the Newark system:

	Page.
Geological section showing foreign equivalents	36
Age and geographical extent	173-194
Age determined from relation to associated rocks	173-174
Age indicated by organic remains	124
Thickness	174-175
Boundaries	175-176
Trap rocks, general description of	176-194
Bergen neck and Palisade mountain (boundaries described)	176-178
Staten island, New York	178
Big Snake hill, Little Snake hill	178-179
First and Second mountains (boundaries described)	179-185
Third mountain	185
Packanack	185
Towakhow or Hook mountain (boundaries described)	186
Riker or Morehouse hill	186
Long hill (boundaries described)	186-187
Basking ridge	187-188
New Vernon and Loantaka	188
Ramapo valley	188-189
Lawrence brook or Dean pond, Ten-Mile Run mountain, and Rocky hill (boundaries described)	189-190
Pennington mountain	190
Bald Pate mountain	190-191
Belle mountain	191
Sourland mountain (boundaries described)	191-192
Alexsocken creek	192
Point pleasant	192-193

COOK, GEORGE H.—Continued.

	Page.
Pickler, or Round Valley mountain (boundaries described)	193
Round mountain	193-194
New Germantown and Silver hill	194
Geological structure	195-205
Dips, table of	195-199
Sections described (the sections are on map in portfolio)	199-201
Joints, table showing direction of	201
Faults	202
Trap rocks, relation of to sedimentary beds	202-205
Joints in trap, table of	305
Rocks	206-207
Sandstone, conglomerate, shale, basalt, etc., brief account of	206-207
Sandstone, detailed description of outcrops, etc	208-209
Conglomerate, detailed description of outcrops, etc	209-212
Shale, detailed description of outcrops, etc	212-214
Limestone, detailed description of outcrops, etc	214-215
Trap rock, detailed description of outcrops, etc., with analyses	215-218
Minerals and ores	218-225
Geology of the surface	226-238
Soils derived from sandstone, shale, and trap	226
Glacial drift	227-229
River terraces	227
Æolian sand	227-228
Glacial scratches, table of	228
Tide marshes	230-238
Theoretical considerations relating to mode of formation, origin of the trap, historical geology rock, color of the sandstone, etc	336-339
Building materials (sandstones)	504-512
Ores of copper	675-680
Extinct reptilia (by Edw. D. Cope), Appendix B	733
Minerals, list of (by E. Seymour), Appendix D	743-750

COOK, GEORGE H. **1871.**

[Annual report of the state geologist of New Jersey, for the year 1870].

New Brunswick, N. J. Pp. 1-75, pl. 4.

Deposits of copper ore described, pp. 55, 57.

COOK, GEORGE H. **1873.**

Geological Survey of New Jersey. Annual report of the state geologist for the year 1873.

Trenton, N. J. Pp. 1-128, pl. 2.

Junction of Newark and Azoic rocks mentioned, pp. 13-14. Color given to Newark rocks on geological map, p. 22. Copper ores briefly mentioned, pp. 98-99. Part of the east boundary of the Newark system briefly described, p. 103.

COOK, GEORGE H. **1874.**

Geological Survey of New Jersey. Annual report of the state geologist for the year 1874.

COOK, GEORGE H.—Continued.

Trenton [N. J.]. Pp. 1-115, with map.

Copper ores, p. 32. Junction of Newark and Cretaceous rocks mentioned, p. 43. Native iron in trap rocks, pp. 56-57.

COOK, GEORGE H. 1876.

Catalogue of the Centennial exhibit of the Geological Survey of New Jersey.

[Trenton, N. J.] Pp. 1-84.

Brief account of extent of the Newark system in New Jersey, with catalogue of 30 specimens of sandstones, shale, flagstone, conglomerate, and trap, pp. 24-25. Four other specimens of sandstone mentioned on p. 45.

COOK, GEORGE H. 1878.

Geological survey of New Jersey. Annual report of the state geologist for the year 1878.

Trenton, N. J., pp. 1-131, with map in pocket. Glacial markings in trap rock, p. 10. Soil formed from Newark shales, pp. 24-25, 29. Soil from trap rock ridges, p. 39. Coal in thin seams, p. 110.

COOK, GEORGE H. 1879.

Geological survey of New Jersey. Annual report of the state geologist for the year 1879.

Trenton, N. J., pp. 1-199, pl. 1, and geological map of New Jersey in pocket.

	Page.
Geographical position of the Newark rocks in New Jersey, mentioned	12-13
General boundaries of the Newark system, soil and area	14
Boundaries of Newark system described	18
Character of rocks	18
Conglomerate along the west border of the Newark	19
Quarries of sandstone	19-20
Trap rocks, general description of	20
Coal, thin seams of	20
Copper ores	21
Brownstone, quarries of	21-25
Flagstone, quarries of	25
Trap rock, quarries of	25-26
Fossils, plants, fishes, and footprints	26-29
Freshwater origin of the Newark system (stated)	29
Tables of dips in the red sandstone	29-30
Thickness of the Newark	30-31
Source of material	31
Trap, intrusive nature of	32
Supposed faults	32-33
Folds	33
Magnesian limestone	33
Change of dip near the trap ridges. Intrusive character of the trap	34
Sandstone and conglomerate bordering gneiss	39
Artesian and bored wells	126, 128, 129 131, 133, 139, 150

COOK, GEORGE H. 1880.

Geological survey of New Jersey. Annual report of the state geologist for the year 1880.

Trenton, N. J., pp. 1-220, pl. 1, and folding map.

Abstract in Am. Jour. Sci., 3d ser., vol. 22, pp. 77-78.

Contains an account of certain deep wells bored in the Newark rocks, including the record of a well at Paterson with analysis of water obtained, pp. 162-166. Brief statement concerning deep wells in Jersey City.

COOK, GEORGE H. 1881.

Geological survey of New Jersey. Annual report of the state geologist for the year 1881.

Trenton, N. J., pp. 1-87, 1-107, i-xiv, and map.

Brief account of reopening of copper mines, pp. 39-40. Description of the building stones of the Newark system, pp. 42-64.

COOK, GEORGE H. 1882.

Geological survey of New Jersey. Annual report of the state geologist for the year 1882.

Camden, N. J., pp. 1-191, pl. 1-6, and 3 maps.

	Page.
Red sandstone district	11-12
Age of the Newark system	11-12
Structure, review of papers relating to	12-14
Hypothetical explanation of the formation of the Newark system	14-16
Faults and folds	16.17
Detailed description of the Newark system in New Jersey	17-66
Shales	19-26
Sandstone	20-21
Conglomerate	21-22
Limestone	22
Trap rock	22
Dip, unconformity of	22-23
Dips, table of	24-30
Hypothesis to account for dips	30-36
Lithological character	33-35
Hypothesis relating to structure	35-36
Descriptions of exposures	33-42
Trap rocks	43-66
Limestones	112-113

Little Falls, N. J., view of (Cook, '82, pl. 2).

COOK, GEORGE H. 1883.

Geological survey of New Jersey. Annual report of the state geologist for the year 1883.

Camden, N. J., pp. 1-188, pls. 1-3.

Abstract in Am. Jour. Sci., 3d ser., vol. 27, pp. 408-409.

Contains a brief review of a paper "On the relations of the Triassic traps and sandstones of the eastern United States," by W. M. Davis. The conclusion reached by Davis in reference to the extrusive origin of the Watchung mountain trap, is controverted, and facts presented with the view of showing that all the trap rocks of New Jersey are intrusive. In this discussion a summary is given of localities in New Jersey, where metamorphism adjacent to trap rock has been observed, pp. 22-26.

Native iron, and copper ores, pp. 162-166.

COOK, GEORGE H. 1884.

Geological survey of New Jersey. Annual report of the state geologist for the year 1884.

Trenton, N. J., pp. 1-168, pls. 1-5.

Abstract in Am. Jour. Sci., 3d ser., vol. 30, pp. 161-162.

Contains description with illustrations of an exposure of columnar trap at Orange, pp. 23-28.

Artesian wells with analyses of water, pp. 135-136.

COOK, GEORGE H. 1885.

Geological survey of the state of New Jersey. Annual report of the state geologist for the year 1885.

Trenton, N. J., pp. 1-228, pls. 1-13.

Abstract in Am. Jour. Sci., 3d ser., vol. 33, p. 79.

An incomplete list of localities in New Jersey, where fossils have been found, together with names of some of the specimens obtained, pp. 95-96.

Artesian and bored wells, with some account of the strata passed through, together with several analyses of the water obtained, pp. 111-123.

A section of Newark rocks between Jersey City and Boonton, on pl. op. p. 109.

COOK, GEORGE H. 1886.

Sketch of the geology of the Cretaceous and Tertiary formations of New Jersey.

In geological survey of New Jersey, brachiopoda and lamellibranchiata of the Raritan clays and greensand marls of New Jersey, by Robert P. Whitfield. Trenton, N. J., 4to., pp. i-xx, 1-338, pls. 1-35, with folding geological map of New Jersey.

Published also as Monograph IX, U. S. Geological Survey.

Junction of Cretaceous and Newark described, and shown in diagrams, p. x. On the map a portion of the Newark system is shown.

COOK, GEORGE H. 1887.

Geological survey of New Jersey. Annual reports of the state geologist for the year 1886.

Trenton, N. J., 1887, pp. 1-254, and two maps.

Reviewed in Science, vol. 9, 1887, pp. 595-596.

Describes briefly the general condition of the Newark rocks in New Jersey, and notices briefly the various explanations of their structure, character of trap sheets, etc., that have been suggested.

COOK, GEORGE H. 1888.

Report of the subcommittee [of the International Geological Congress] on Mesozoic.

In Am. Geol., vol. 2, pp. 257-261. Published also in International Cong. Geol. Am. Comm. Rep., 1888, pp. E1-E15.

Contains a brief review of the Newark system.

COOK, GEORGE H. 1889.

Geological survey of New Jersey. Annual report of the state geologist for the year 1888.

COOK, GEORGE H.—Continued.

Camden, N. J., 1889, pp. 1-87, pl. op. p. 42.

An introduction to F. L. Nason's paper on the Newark system in New Jersey (pp. 11-13). States briefly the boundaries of the system, its area, and the character of its principal rocks, mode of their formation, thickness, structure, etc. Presents two sections showing small faults.

COOK, GEORGE H. 1889 *a*.

On the International Geological Congress, and our part in it as American geologists.

In Am. Assoc. Adv. Sci., Proc., vol. 37, pp. 159-177.

Expresses belief that faults have been identified in the Newark system, which explain its structure and apparent great thickness. Refers also to the position of the system in the geological column.

COOK, G. H. Analysis of trap from New Jersey, by (J. D. Dana, '73, vol. 6, p. 106).

Cited on analysis of sandstone from New Jersey (Wurtz, '71).

Cited on columnar trap near Orange, N. J. (Iddings, '86, p. 329).

Cited on conglomerate near Paterson, N. J. (Darton, '90, p. 17).

Cited on curved form of certain trap ridges (W. M. Davis, '83, p. 307).

Cited on dips, indicating a fault in New Jersey (Lewies, '85, p. 451).

Cited on footprint localities in New Jersey (C. H. Hitchcock, '88, p. 122).

Cited on former extent of the Newark system (J. D. Dana, '83).

Cited on geology near Martin's dock, New Jersey (W. M. Davis, '83, p. 276).

Cited on the cause of the monoclinal structure of the Newark rocks of New Jersey (W. M. Davis, '86, p. 343).

Cited on the inclination of the red sandstone of New Jersey (Walling, '78, p. 196).

Cited on the occurrence of conglomerate along the Delaware in New Jersey (Russell, '78, pp. 235-236).

Cited on the origin and deposition of Newark strata (W. M. Davis, '83, p. 287).

Cited on the origin of the red color of the Newark sandstone (Russell, '89, p. 50).

Cited on the origin of prevailing dip of the Newark rocks of New Jersey (Wurtz, '70, pp. 99-100).

Cited on the tilting of sandstone and trap in New Jersey (W. M. Davis, '83, pp. 302, 303).

Cited on trap dikes in New Jersey (W. M. Davis, '83, p. 292).

Cited on upper contact of palisade trap sheet, New Jersey (Davis and Whittle, '89, p. 106).

Notice of work done by in New Jersey (Miller, '79-'81, vol. 2, pp. 157-158).

COOK, GEORGE H., and SMOCK, JOHN C. 1874.

Geological survey of New Jersey. [A geological map of] northern New Jersey, showing iron ores and limestone districts, scale 2 miles to 1 inch.

COOK, GEO. H., and SMOCK, JOHN C.—Cont'd.

New York. Two sheets in an envelope. [Revision of edition of 1868.]

Includes a portion of the area occupied by Newark sandstone and trap.

COOK, GEORGE H. and JOHN C. SMOCK. 1878.

Geological survey of New Jersey. Report on the clay deposits of Woodbridge, South Amboy and other places in New Jersey.

Trenton, N. J. Pp. 1-381, pls. 2, and map in pocket.

The references to the Newark system in this volume are brief and incidental to the description of the Cretaceous clays, etc. An unconformity between the Plastic clays at the base of the Cretaceous and the Newark rocks beneath is stated, pp. 5, 24, 39, 171, 172. Several localities are also described where the Newark has been reached in excavations begun in clays, pp. 304-305.

Cook's gap, Conn. Description of trap ridges near (Percival, '42, pp. 370-371, 373, 375, 376, 379, 381).

Detailed study of the geological structure near (W. M. Davis, '89).

Sketch map of (W. M. Davis, '89, pl. 5).

Coontown, N. J. Dip at (Cook, '68, p. 196).

Dip in shale near (Cook, '79, p. 30).

COOPER, THOMAS. 1822.

On volcanoes and volcanic substances with a partial reference to the origin of the rocks of the floetz trap formation.

In Am. Jour. Sci., vol. 4, pp. 205-243.

Contains a general account of the trap rocks of the Newark system from Massachusetts to North Carolina. The trap is considered of igneous origin, pp. 239-243.

Coopersburg, Pa. Dip near (Lesley, '83, p. 180).

Dip of shale at (H. D. Rogers, '58, vol. 1, p. 101).

Ripple marks at (H. D. Rogers, '58, vol. 1, p. 101).

Cooperstown, Pa. Boundary of the Newark near (H. D. Rogers, '41, p. 16, 39).

Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).

COPE, [E. D.] 1866.

[Remarks on extinct vertebrates from the Mesozoic red sandstone of Pennsylvania.]

In Philadelphia Acad. Nat. Sci., Proc., vol. 18, pp. 249-250, 290.

Presents the results of an examination of certain vertebrate fossils from Phoenixville, Pa., and describes a new Mastodonsaurus; states that the fossils in question properly belong to the Keuper or upper division of the Trias.

COPE, EDWARD D. 1868.

Synopsis of the extinct reptilia found in the Mesozoic and Tertiary strata of New Jersey.

In geology of New Jersey; by George H. Cook. Newark [N. J.], 1868, pp. 733-737.

Brief remarks on the general character of *Clepsysaurus pennsylvanicus*.

COPE, EDWARD D. 1869.

Synopsis of the extinct batrachia, reptilia, and aves of North America.

In Am. Phil. Soc., Trans., n. s., vol. 14, 1871, pp. 1-252, pls. 1-14.

Abstract in Am. Jour. Sci., 2d ser., vol. 49, pp. 390-392.

Presents a synopsis of the batrachians and reptiles that have been described from the Newark system.

COPE, [E. D.] 1870.

Observations on the reptilia of the Triassic formations of the Atlantic region of the United States.

In Am. Philo. Soc., Proc., vol. 11, 1871, pp. 444-446.

Abstract of a paper in which several fossil reptiles from the rocks mentioned are reclassified and a new fossil reptile from Phœnixville, Pa., briefly described.

COPE, EDWARD D. 1872.

Observations on the distribution of certain extinct vertebrata in North Carolina.

In Am. Philo. Soc., Proc., vol. 12, 1871-1872, pp. 210-216, pls. 1-4.

Discusses the biological relation of certain fossil reptiles from North Carolina and Pennsylvania.

COPE, EDWARD D. 1875.

Synopsis of the vertebrata whose remains have been preserved in the formations of North Carolina.

In report on the geological survey of North Carolina, vol. 1, by W. C. Kerr. Appendix B, pp. 29-52, pls. 5-8.

Contains references to or descriptions of fossil fishes, batrachians and reptiles, pp. 30, 32, 34-35, pl. 8.

COPE, E. D. 1877.

Descriptions of extinct vertebrata from the Permian and Triassic formations of the United States.

In Am. Philo. Soc., Proc., vol. 17, 1878, pp. 182-196.

Describes a number of vertebrate fossils from Phœnixville, Pa.

COPE, E. D. 1877.

On some saurians found in the Triassic of Pennsylvania, by Mr. C. M. Wheatley.

In Am. Philo. Soc., Proc., vol. 17, 1878, pp. 231-232.

Describes fossil reptilian remains from Phœnixville, (?) Pa.

COPE, E. D. 1885.

[Vertebrate fossils of the Triassic beds of Pennsylvania.]

In sketch of the geology of York county, Pa.

In Am. Philo. Soc., Proc., vol. 23, 1886, pp. 403-404.

Presents a list of twelve species of vertebrate fossils from the rocks mentioned.

COPE, E. D. 1885a.

Marsh on American Jurassic dinosauria.

In Am. Nat., vol. 19, pp. 67-68.

A review of "The principal characters of American Jurassic dinosaurs," by O. C. Marsh.

COPE, E. D. 1887.

A contribution to the history of the vertebrata of the Trias of North America.

In Am. Phil. Soc. Proc., vol. 24, pp. 209-228, pls. 1, 2.

Describes vertebrate fossils from Pennsylvania and North Carolina.

COPE [E. D.]. 1888.

Mesozoic realm.

In report of the subcommittee [of the International Geological Congress] on Mesozoic. By George H. Cook.

In Am. Geol., vol. 2, pp. 261-268.

Published also in International Cong. Geol., Ann. Comm., Rep. 1888, pp. E7-E9.

Contains a brief review of the Triassic and Jurassic systems of North America.

COPE, E. D. 1889.

[Review of H. F. Osborn's paper on the structure and classification of Mesozoic mammalia.]

In Am. Nat., vol. 23, pp. 723-724, pl. 14.

States the contents of the paper received. Reproduces one of the plates.

COPE, E. D. Cited on the age of the Mesozoic sandstone of York county, Pa. (Frazer, '85, p. 403).

COPE, E. D. Notice of the study of fossil reptiles from Pennsylvania by (Miller, '79-'81, vol. 2, pp. 156, 223, 233).

Copeville, Pa. Mention of trap dike near (Frazer, '89, p. 693).

Copper, deposition of, in (Chapman, '56, pp. 43-45).

Copper hill station, N. J. Dip near (Cook, '68, p. 197).

Dip in shale near (Cook, '82, p. 26).

Copper hill, N. J. Indurated shale at (Cook, '82, p. 63).

Copper in Connecticut valley. Associated with trap (Percival, '42, p. 318).

Brief account of (E. Hitchcock, '35, pp. 71-72. E. Hitchcock, '35, pp. 228-229. E. Hitchcock, '41, p. 448. Brongniart and Silliman, '22. Percival, '42, p. 318. Silliman, '21, pp. 221, 222).

Discussion concerning (Gilbert, '22, '22*a*. Hoffman, '22. Silliman and Whitney, '55).

From Farmington, Conn. (Percival, '42, p. 376).

From Mt. Carmel trap ridge, Connecticut (Percival, '42, pp. 320-321).

From West Rock and in North Hamden, Conn. (Percival, '42, p. 436).

Copper in Nova Scotia (How, '69, pp. 65-66, 72. Gesner, '36, pp. 193, 234. Gesner, '36, pp. 192, 193. Willimott, '84, pp. 20L, 21L).

Copper in Pennsylvania. Brief account of (Frazer, '77*c*. Frazer, '82, pp. 131-134. H. D. Rogers, '58, vol. 2, p. 763).

In Adams county (H. D. Rogers, '58, vol. 2, p. 691).

Detailed account of (Frazer, '80, pp. 299-304).

In York county. Notice of (Frazer, '85, p. 403).

Copper in Pennsylvania—Continued.

Near Gettysburg. Exploration for (Frazer, '77, pp. 263-264).

On the occurrence of, near Gettysburg (Frazer, '77*b*).

Copper, native, associated with trap (Silliman and Houghton, '44).

From the bay of Fundy (Gilpin, '77, p. 749).

From Bridgewater mine, New Jersey (Cook, '81, p. 39).

From cape Dory, Nova Scotia (Alger, '27, p. 232).

From Hamden hills, Connecticut (Silliman, '14, p. 149).

From Long island, Nova Scotia (Gesner, '36, p. 174).

From Simsbury mines, Massachusetts (E. Hitchcock, '35, p. 229).

From Wallingford, Connecticut (Silliman, '18).

From Whately, Massachusetts (E. Hitchcock, '44*b*).

From Woodbridge, New Jersey. Mention of (Akerly, '20, p. 61).

In connection with trap sheets (Jackson, '50, p. 336).

Localities where found (Cleaveland, '22, p. 555).

Copper ore in New Brunswick. On Grand Manan island (Bailey, '72, pp. 47, 221, 225, 226. Chapman, '72. Chapman, '78, p. 106.)

Copper ore in New Jersey. At Bellville (Cook, '81, p. 46).

At Copper hill (Cook, '68, p. 679).

At Flemington. Report on (E. and C. H. Hitchcock, '59).

At Somerville. Analysis of (Bowen).

Brief account of (Cook, '71, pp. 55-57. Credner, '70).

Description of (H. D. Rogers, '40, pp. 147, 148).

Description of (H. D. Rogers, '36, pp. 166-170).

Detailed description of (H. D. Rogers, '40, pp. 158-165).

In Hudson county. Reference to (Russell, '80, pp. 33, 34, 35).

Mention of (Cook, '73, pp. 98-99. Cook, '79, p. 21. Cook, '81, pp. 39-40. Cook, '82, p. 53. Cook, '83, pp. 164-166).

Near New Brunswick (Beck, '39).

Near Warrenville (Cook, '74, p. 32).

Occurrence of (Cook, '68, pp. 218-224, 675-680).

Reference to early working of (D. S. Martin, '88, p. 8).

Reference to in Raritan clays. Derived from the Newark system (Cook and Smock, '78, p. 43).

Reopening of mines (Cook, '81, pp. 39-40).

Report on the Hunterdon copper mine (Dickeson, '59).

Copper ores in South Carolina (Lieber, '56, p. 51).

Origin of (T. S. Hunt, '83*a*, p. 201. Newberry, '73).

Relation of, to trap (Lyell, '54, p. 33).

Coprolites from the Connecticut valley. Analyses of (S. L. Dana and E. Hitchcock, '45).

Character of (Lyell, '66, p. 455).

Discussions of (E. Hitchcock, '44*a*, pp. 308–314. Warren, '54, p. 46).

CORNELIUS, ELIAS. **1818.**

On the geology, mineralogy, scenery, and curiosities of parts of Virginia, Tennessee and the Alabama and Mississippi Territories [etc.].

In Am. Jour. Sci., vol. 1. pp. 215–226, 317–331.

Contains a brief description of the conglomerate (breccia) of the Potomac river; also a short notice of the general features of the Newark areas in Virginia, pp. 216–217.

Cornwall, Pa. Boundary of the Newark near (see Frazer, '82, p. 123).

Section of, near (H. D. Rogers, '58, vol. 2, pp. 718–719).

Sedimentary beds near (d'Invilliers, '86*a*, pp. 890–879).

Trap dikes near (H. D. Rogers, '58, vol. 2, pp. 718, 719).

Trap rocks near (d'Invilliers, '86*a*, pp. 876–879).

Cornwall coal mine, Va. An account of (Grammar, '18, p. 127).

Cornwall ironworks, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 669).

Cornwallis, N. S. Manganese at (Gilpin, '85, p. 8).

Rocks of (Gesner, '36, p. 80).

Unconformity at base of the Newark in (Dawson, '78, p. 110).

Cornwallis valley, N. S. Dip of sandstone in (Dawson, '78, p. 91).

Erosion of (Dawson, '47, p. 56).

Cornwall mine, Pa. Association of magnetite with trap at (Frazer, '80, p. 27).

Detailed description of (Lesley and d'Invilliers, '85).

Iron ore of (H. D. Rogers, '39, p. 22).

Cornwell, S. C. Magnetic ore near (Tuomey, '48, p. 68).

CORYELL, MARTIN. **1875.**

East Virginia coal field.

In Am. Inst. Mining Eng., Trans., vol. 3, pp. 228–231.

Gives a list of papers that have been published on the Richmond coal field, and also a section of coal seams at Carbon hill.

CORYELL, MARTIN. **1875.**

[Remarks on mining and on natural coke in the Richmond coal field, Virginia.]

In the Engineering and Mining Journal, vol. 19, p. 35.

Discussion of a paper by O. J. Heinrich, on deep borings with a diamond drill, read before the American Institute of Mining Engineers, December 26, 1874. States that excellent coal in thick seams, exists in the Richmond coal field, Virginia, and also that the field has not been greatly disturbed. Describes a vein of natural coke or "carbonite" 5 feet thick on the north side of the James. Remarks were also made by O. J. Heinrich and T. S. Hunt.

Couch's coal mine, Va. Thickness of coal in (W. B. Rogers, '36, p. 53).

Cove, Westfield, Conn. Fossil foot prints at (E. Hitchcock, '58, pp. 50 et seq.).

Fossil fucoid from (E. Hitchcock, '41, p. 450, pl. 29).

Report of the discovery of foot prints at (E. Hitchcock, '37).

Coweta, Ga. Brief account of trap dikes in (Henderson, '85, p. 88).

Trap dikes in (Loughridge, '84, p. 279).

Cox's coal mine, Va. Analysis of coal from (Macfarlane, '77, p. 515).

Cox iron mine, Pa. Description of (d'Invilliers, '86, p. 1504–1505).

COZZENS, ISSACHAR. **1843.**

A geological history of Manhattan or New York island [etc., etc.]

New York, pp. 1–114, pls. 1–9.

Describes the trap and associated sedimentary rocks on the west side of the Hudson, near New York city.

Cranberry point, N. S. Relation of trap, conglomerate, and sandstone at (Gesner, '43).

Cranche's colliery, Va. Analysis of coal from (Clifford, '87, p. 10).

Crane (U. S. C. S. station) N. of Montclair, N. J. Elevation of First mountain at (Cook, '82, p. 49).

Crane's gap, N. J. Boundary of First mountain trap near (Cook, '68, p. 181).

Dip at (Cook, '68, p. 195).

Crapaud, P. E. I. Description of fossil wood from (Dawson, '54).

Silicified wood at (Dawson and Harrington, '71, p. 16).

CREATH, A. S. Analysis of limestone from Dillsburg, Pa. (Frazer, '76*c*, p. 63*c*).

CREDNER, HERMANN. **1865.**

Geognostische Skizze der Umgegend von New York.

In Zeitsch. Deutsch. geol. Gesell., vol. 17, pp. 388–398, pl. 13.

Describes diorite dike west of New York, with an account of its composition, structure, extent, and contact with sandstone on the west.

CREDNER, HERMANN. **1865.**

Geognostische Reiseskizzen aus New Brunswick in Nordamerika.

Neues Jahrbuch, 1865, pp. 803–821.

Describes the rocks of Quaco, New Brunswick, referring them to the Permian. States that the Triassic and Jurassic formations are not known in New Brunswick.

CREDNER, HERMANN. **1866.**

Geognostische Skizzen aus Virginia, Nordamerika.

In Zeitsch. Deutsch. geol. Gesell., vol. 18, pp. 77–85.

Gives a brief description of Clover hill coal basin, Virginia. Discuses differences of opinion as to the age of the coal and the impossibility of correlating with European formations.

CREDNER, HERMANN. 1870.

Die Kreide von New Jersey.

In Zeitsch. Deutsch. geol. Gesell., vol. 22, pp. 191-251.

Describes, incidentally, the Newark rocks in New Jersey and associated dikes and sheets of diorite and melaphyre, pp. 196-197. Copper at contact of red sandstone and the eruptive rocks, p. 197. Relation of red sandstone to Cretaceous and underlying gneiss, p. 200.

CREDNER, HERMANN. 1871.

Die Geognosie und der Mineralreichthum des Alleghany Systems.

In Petermann's Mitth., vol. 17, 1871, pp. 41-50.

Brief description of extent and character of the Newark system, pp. 44-45.

Creek Company's coal mine, Va. Analysis of coal from (Clifford, '87, p. 10. Macfarlane, '77, p. 515. Williams, '83, p. 82).

Brief account of (Macfarlane, '77, p. 507).

Character and efficiency of coal from (W. R. Johnson, '50, pp. 133-134, and table op. p. 134).

Depth of (W. B. Rogers, '43*b*, p. 534).

Fossil crustaceans from (Jones, '62, p. 86).

Notes on (Taylor, '35, p. 284).

Thickness of coal in (Taylor, '35, p. 282).

Trial of the coal of, for heating purposes (W. R. Johnson, '44, pp. 349-362).

CROSBY, W. O. 1876.

Report on the geological map of Massachusetts.

Boston, pp. 1-52.

Published under the direction of the Massachusetts Commission to the Centennial Exposition.

Contains a brief reference to the Newark system. The map has not been published. The copy exhibited at the Centennial Exhibition, I have been informed by Mr. Crosby, is now in the State house at Boston.

Croton, N. J. Dip in indurated shale near (Cook, '82, p. 27).

Trap outcrop near (Cook, '82, p. 63).

Crouch's coal mine, Va. Analysis of coal from (Macfarlane, '77, p. 515. Williams, '83, p. 82).

Notes on (Taylor, '35, p. 284).

Crouch and Snead's coal mine, Va. Trial of the coal of, for heating purposes (W. R. Johnson, '44, pp. 325, 337, 448).

Crustaceans, fossil. Footprints of (Agassiz, '58).

Footprints of, from Connecticut valley (Dana, '58*a*. E. Hitchcock, '58, pp. 48, 147-160, pls. 25, 28-31, 49, 50. E. Hitchcock, '65, pp. 17-18, pl. 2. Leidy, '58).

From Newark system. Remarks on (H. D. Rogers, '58, vol. 2, p. 695).

From North Carolina. Brief account of (Emmons, '56, p. 323. Emmons, '57, pp. 38-42. Emmons, '57, p. 134).

List of (Kerr, '75, p. 147).

From Pennsylvania. Mention of (H. D. Rogers, '58, vol. 2, pp. 692-693. Wheatley, '61, p. 43. Wheatley, '61*a*).

Crustaceans, fossil—Continued.

From Virginia (W. B. Rogers, '55*b*).

List of, after W. B. Rogers (Heinrich, '78, p. 264).

Of the Newark system. Brief discussion of (W. B. Rogers, '54).

Crystal lake, N. J. Trap hill near (Cook, '82, p. 49).

Culpeper county, Va. Character of conglomerate in (W. B. Rogers, '39, p. 72).

Description of the Newark in (W. B. Rogers, '40, pp. 64-69).

Culpeper court house, Va. Boundaries of the Newark near (W. B. Rogers, '40, p. 62).

Description of conglomerate at (Fontaine, '79, p. 33).

Detailed description of geology near (W. B. Rogers, '40, pp. 66, 67).

Fossil crustaceans from (Jones, '62, p. 124).

Culp's hill, Pa. Dolerite from near (Frazer, '76, pp. 160-161).

Specimens of trap from (C. E. Hall, '78, pp. 24-27).

Cumberland Newark area, Va. Position and brief description of (Fontaine, '83, pp. 4, 6-7).

Cumberland county, Pa. Description of stony ridge in (Gibson, '20).

Geological map of (Lesley, '80).

Report on the geology of (Frazer, '77).

Cumberland county, Va. Boundaries of the Newark in (W. B. Rogers, '39, pp. 74, 76-77).

Description of the geology of (W. B. Rogers, '39, pp. 77-81).

Probability of finding coal in (W. B. Rogers, '39, p. 79).

Section in (W. B. Rogers, '39, p. 80).

Cunliff's coal mine, Va. Notes on (Taylor, '35, p. 284).

Cushetunk mountain, N. J. Description of (Cook, '82, pp. 64-65).

Detailed description of (Darton, '90, pp. 62-65).

Mention of trap conglomerate near (Nason, '90).

Origin of trap of (Darton, '89, p. 138).

DADDOW, SAMUEL HARRIS. Cited on Richmond coal field (Clifford, '88).

DADDOW, SAMUEL HARRIS, and BENJAMIN BANNAN. 1866.

Coal, iron, and oil [etc., etc.].

Pottsville, Pa. Pp. 1-808, and map.

Contains an account of the coal fields of eastern Virginia and of North Carolina. pp. 393-406.

Dalla's bridge, Va. Boundary of Newark near (Heinrich, '78. p. 238).

DANA, EDWARD S. 1872.

On the datholite from Bergen hill, New Jersey.

In Am. Jour. Sci., 3d ser., vol. 4, pp. 16-22, pl. 1.

Abstract in Neues Jahrbuch, 1872. pp. 643-644.

DANA, EDWARD S. 1875.

Trap rocks of the Connecticut valley.

In Am. Assoc. Adv. Sci., Proc., vol. 23, section B, pp. 45-47.

Abstract in Am. Jour. Sci., 3d ser., vol. 8, pp. 390-392; and in Neues Jahrbuch, 1875, p. 427.

DANA, EDWARD S.—Continued.

A preliminary microscopic examination of trap rock from more than a hundred localities.

DANA, EDWARD S. **1877.**

On the occurrence of garnets with the trap of New Haven, Conn.

In Am. Jour. Sci., 3d ser., vol. 14, pp. 215–218.

Describes the occurrence of garnets in the trap of West rock, East rock, and Mill rock, Conn.

DANA, EDWARD S. Cited as to the composition of trap rocks (W. M. Davis, '83, p. 284).

Cited on the optical properties of trap from Connecticut (Frazer, '75*b*).

Cited on the trap rocks of Connecticut (Hovey, '89, pp. 364–368).

Cited on trap (dolerite) in the Connecticut valley (Iddings, '86, p. 331).

Cited on tufaceous conglomerate in Massachusetts (W. M. Davis, '83, p. 263).

DANA, JAMES D. **1843.**

On the analogies between the modern igneous rocks and the so-called Primary formations, and the metamorphic changes produced by heat in associated sedimentary deposits.

In Am. Jour. Sci., vol. 45, pp. 104–122.

Cites H. D. Rogers in reference to contact metamorphism at Rocky Hill, N. J., pp. 113–115.

DANA, JAMES D. **1845.**

Origin of the constituent and adventitious minerals of trap and the allied rocks.

In Am. Jour. Sci., vol. 49, pp. 49–64.

Published also in Am. Assoc. Geol. and Nat., Proc., 6th meeting, pp. 26–28.

Abstract in Neues Jahrbuch, 1847, pp. 218–223.

Considers the "essential constituents of modern plutonic rocks" and "minerals occupying cavities and seams in amygdaloidal trap or basalt."

DANA, JAMES D. **1845a.**

On the minerals of trap and the allied rocks.

In Am. Assoc. Geol. and Nat., Proc., 6th meeting, pp. 26–28.

Published also in Am. Jour. Sci., vol. 49, pp. 49–64.

Discusses the origin of adventitious and secondary minerals in trap rocks.

DANA, JAMES D. **1847.**

On the origin of continents.

In Am. Jour. Sci., 3d ser., vol. 3, pp. 94–100.

Brief statement of a hypothesis to the effect that the trap dikes of the Newark system may be a result of contraction subsequent to the Carboniferous, pp. 99–100.

DANA, JAMES D. **1847a.**

Origin of the grand outline features of the earth.

In Am. Jour. Sci., 2d ser., vol. 3, pp. 381–398.

The trap ridges of the Connecticut valley are referred to as illustrating the view that certain grand features of the earth's surface have resulted from fissures, pp. 391–392.

DANA, JAMES D. **1847b.**

[Note on phalangial impressions in fossil footprints.]

See Silliman, Silliman, jr., and Dana, 1847.

DANA, JAMES D. **1847c.**

[Note on] Ornithichnites.

See Silliman and Dana, 1847.

DANA, [J. D.] **1855.**

[A note relating to a new fossil plant from the Connecticut valley sandstone.]

In Boston Soc. Nat. Hist., Proc., vol. 5, p. 212.

Brief reference to a letter relating to the finding of a specimen of Clathropteris in the sandstone of the Connecticut valley.

DANA, J. D. **1856.**

On American geological history: Address before the American Association for the advancement of Science. August, 1855.

In Am. Jour. Sci., 2d ser., vol. 22, pp. 305–334. Published also in Am. Assoc. Adv. Sci., Proc., vol. 9, pp. 1–36.

States briefly the leading facts concerning the distribution, thickness, mode of formation, and geological position of the Newark system, pp. 321–323. A brief abstract is also given of the conclusions of previous writers in reference to the age of the deposits in question, footnote p. 322.

DANA, JAMES D. **1856a.**

Plan of development in the geological history of North America.

In Am. Assoc. Adv. Sci., Proc., vol. 10, 1857, pt. 2, pp. 1–18, and a map op. p. 9.

Contains a brief reference to the position of the eastern continental margin during the Newark period, p. 11.

DANA, JAMES D. **1857.**

Additional remarks [on E. Emmons' geological report of the midland counties of North Carolina].

In Am. Jour. Sci., 2d ser., vol. 24, pp. 429–430.

Remarks on the determination of the geological position of the Newark system.

DANA, JAMES D. **1858.**

[Note on a supposed fossil insect from Turner Falls, Mass.]

In Ichnology of New England, by Edward Hitchcock, pp. 7–8.

Gives a brief description of a supposed fossil insect from the Connecticut valley sandstone, subsequently named *Mormolucoides articulatus* by Hitchcock.

DANA, JAMES D. **1858a.**

[Note on supposed crustacean tracks in Connecticut valley sandstone.]

In Ichnology of New England, by Edward Hitchcock, p. 165.

An extract from a letter referring to certain drawings of footprints, supposed to have been made by crustaceans.

DANA, JAMES D. **1859.**

Reply to Prof. Agassiz on Marcou's Geology of North America.

In Am. Jour. Sci., 2d ser., vol. 27, pp. 137–140.

Reprinted in "Reply to the criticisms of James D. Dana" by Jules Marcou, Zurich, 1859, pp. 30–35.

DANA, J. D. **1862.**

Fossil larvæ in the Connecticut river sandstone.

In Am. Jour. Sci., 2d ser., vol. 33, pp. 451–452.

Quotes the opinion of John Le Conte in reference to the nature of the fossil in question.

DANA, J. D. **1865.**

[A letter relating to the footprints from the Connecticut valley described by Edward Hitchcock.]

In supplement to the Ichnology of New England, by Edward Hitchcock, pp. 33–34.

Contains statements in reference to the character of the footprint animals.

DANA, JAMES D. **1870.**

Excursion to the Hanging hills of Meriden [Connecticut].

In history of Wallingford, Conn. [etc., etc.], by C. H. S. Davis, Meriden, Conn., pp. 53–56.

A popular account of the leading geological features of the region about Meriden, Conn.

DANA, JAMES D. **1871.**

On the geology of the New Haven region, with special reference to the origin of some of its topographical features.

In Connecticut Acad. Sci., Trans., vol. 2. pp. 45–112, and map.

Describes the topography of the region about New Haven, Conn., and discusses briefly its relation to pre-Tertiary geology, pp. 45–47.

DANA, JAMES D. **1871a.**

[Review of "Historical notes on the earthquakes of New England, 1838–1839, by William T. Brigham."]

In Am. Jour. Sci., 3d ser., vol. 1, pp. 304–305.

Percival's determination of the intrusive character of the trap rocks of the Connecticut valley upheld. The eruptions were in all cases through fissures. An outcrop of "scoria" near Durham, Conn., shown to be scoriform sandstone. No eruptions since the Mesozoic, p. 305.

DANA, JAMES D. **1871b.**

[On the presence of albite and orthoclase in the Newark sandstone of New Jersey and Connecticut.]

In Am. Jour. Sci., 3d ser., vol. 2, pp. 459–460.

A notice of a paper by P. Schweitzer relating to the mineralogical composition of certain sandstones in New Jersey, in the Am. Chemist, July, 1871; see also Am. Jour. Sci., 3d ser., vol. 3, p. 57.

D[ANA,] JAMES D. **1872.**

[Note on the character of the trap of the Palisades, N. J., and of trap near New Haven, Conn.]

In Am. Jour. Sci., 3d ser., vol. 4, p. 237.

Review of a paper by Henry Wurtz, on the rocks of the Palisades, N. J. Compares the trap of the Palisades with similar trap in Connecticut.

DANA, JAMES D. **1873.**

On some results of the earth's contraction from cooling, including a discussion of the origin of mountains, and the nature of the earth's interior.

In Am. Jour. Sci., 3d ser., vol. 5, pp. 423–433, vol. 6, pp. 6–14, 104–115, 161–172.

Refers to the Newark system in illustration of various points in the discussion mentioned, vol. 5, pp. 427, 430–431, 432, 437; vol. 6, pp. 8, 9, 106, 108, 114.

DANA, JAMES D. **1874.**

Text-book of Geology [etc.].

New York and Chicago, 12mo., 2d ed., pp. i–vii, 1–358.

The condensed account of the Triassic and Jurassic systems contained in this text-book is essentially the same as is given in the Manual of Geology by the same author, to which references have been given in this index.

DANA, JAMES D. **1875.**

Manual of Geology.

New York, rev. ed., pp. i–xvi, 1–828, plate and map.

1st ed. Philadelphia, 1869, pp. i–xvi, 1–800, plate and map.

Contains a condensed summary of observations concerning the Newark system.

DANA, JAMES D. **1875a.**

On southern New England during the melting of the great glacier.

In Am. Jour. Sci., 3d ser., vol. 10, pp. 168–183, 280–283, 353–357, 409–438, 497–508.

Contains a brief statement in reference to the main topographic features of the Newark sandstone and trap in the vicinity of New Haven, Conn., pp. 170–171. Considers that the Connecticut valley was an estuary during the Newark period, p. 497. Describes the general togography of the valley, and origin of the trap ridge, character of drainage, etc., pp. 497–502.

D[ANA], J[AMES] D. **1878.**

On "indurated bitumen" in cavities in the trap of the Connecticut valley. From the report on the geology of Connecticut by Dr. J. G. Percival.

In Am. Jour. Sci., 3d ser., vol. 16, pp. 130–132.

Presents several extracts from the report mentioned in reference to the occurrence of a solid hydrocarbon in the eruptive rocks of Connecticut.

[DANA], J. D. **1879.**

[Review of] the physical history of the Triassic formation of New Jersey and the Connecticut valley by I. C. Russell.

In Am. Jour. Sci., 3d ser., vol. 17, pp. 328–330.

Reviews the hypotheses proposed in the paper referred to and advances arguments which oppose them.

DANA, JAMES D. **1880, 1881.**

On the geological relations of the limestone belts of Westchester county, New York.

DANA, JAMES D.—Continued.

In Am. Jour. Sci., 3d ser., vol. 20, pp. 21–32, 194–220, 359–375, 450–456; vol. 21, pp. 425–443; vol. 22, pp. 103–119, 313–315, 327–435.

Contains a map of Stony Point, N. Y., showing approximate junction of Newark system and the Cortland series, and also a note in reference to the beds beneath the Newark conglomerate at the same locality, vol. 22, pp. 112, 113.

D[ANA], J[AMES] D. **1881.**

[Review of a paper by G. W. Hawes, on Doleryte (trap) of the Newark system.]

In Am. Jour. Sci., 3d ser., vol. 22, pp. 230–233.

Discusses the chemical and mineralogical composition of trap rocks from New Jersey and the Connecticut valley.

D[ANA], J[AMES] D. **1883.**

The origin of the Jura-Trias of eastern North America.

In Am. Jour. Sci., 3d ser., vol. 25, pp. 383–386.

Notices briefly certain conclusions in reference to the former extent of the Newark system, published in the annual report of the state geologist of New Jersey for 1882, and presents a number of observations and theoretical considerations, with the view of showing that the rocks referred to were formed in various detached areas, at the mouths of rivers which were flooded owing to the prevalence of a cold climate similar to that which prevaled over the same region during the Pleistocene glacial epoch.

DANA, J[AMES] D. **1889.**

Areas of continental progress in North America, and the influence of the conditions of these areas on the work carried forward within them.

In Geol. Soc. Am., Bull., vol. 1, pp. 36–48.

Refers to thick deposits of Newark strata in the southern half of the Connecticut valley, p. 38.

D[ANA], J[AMES] D. **1890.**

[A review of a paper by I. C. Russell on the "Subaerial decay of rocks and origin of the red color of certain formations."]

In Am. Jour. Sci., 3d ser., vol. 39, pp. 317–319.

Discusses the origin of the prevailing red color of the sandstones and shales of the Newark system.

DANA, JAMES D. **1890a.**

Long Island sound in the Quaternary era, with observations on the submarine Hudson river channel.

In Am. Jour. Sci., 3d ser., vol. 40, pp. 425–437.

Discusses the question of glaciation during the Newark period. Pp. 436–437.

DANA, JAMES D. **1891.**

Some of the features of nonvolcanic igneous ejections, as illustrated in the four "rocks" of the New Haven region, West rock, Pine rock, Mill rock, and East rock.

DANA, JAMES D.—Continued.

In Am. Jour. Sci., 3d ser., vol. 42, pp. 79–110, pls. 2-7.

Consists of a critical study of the character of the igneous injections, by which the trap forming the rocks named was introduced among the inclosing sedimentary beds. The principal conclusions are:

The igneous eruptions took place after the tilting of the sedimentary beds inclosing them had been commenced.

The igneous material was not erupted at the surface, and it did not form overflow sheets.

The igneous rocks were injected from below, and made space for themselves by lifting the sedimentary beds, after the manner of laccolites. This took place at comparatively shallow depths.

The course and dip of supplying fissures was not determined by the foliation or bedding of the schist underneath the sandstone.

DANA, JAMES D. **1891a.**

On Percival's map of the Jura-Trias trap belts of central Connecticut, with observations on the upturning, or mountain-making disturbances, of the formation.

In Am. Jour. Sci., 3d ser., vol. 42, pp. 439–447, pl. 16.

Presents facts which are thought to indicate that the trough in which the Newark rocks of the Connecticut valley area were deposited terminated at the south in what is now New Haven bay. Discusses the relative age of the trap ejections and the tilting of the inclosing sandstones, and the character of the mountain uplifts made at or near the close of the Newark period. Discusses the probability of fault planes being concerned in the monoclinal dip of the strata. Reproduces Percival's map of the southern portion of the Newark area of the Connecticut valley.

DANA, J. D. Cited on cause of the tilting of the Newark (W. M. Davis, '83, p. 303).

Cited on character of certain footprints from Turner Falls, Mass. (Deane, '56).

Cited on contact metamorphism in Connecticut (W. M. Davis, '83, pp. 300, 301).

Cited on coprolites from the Connecticut valley (Lyell, '66, p. 455).

Cited on curved form of certain trap ridges (W. M. Davis, '83, p. 307).

Cited on diabases of the Newark system (Hawes, '82, p. 129).

Cited on distribution of Newark areas (S. P. Merrill, '89, p. 446).

Cited on eruption of trap in Connecticut (Davis and Whittle, '89, p. 117).

Cited on extent of the Connecticut valley area (Shaler, '84, p. 127).

Cited on fossil footprints from the Connecticut valley (E. Hitchcock, '63, pp. 53, 55–57).

DANA, J. D.—Continued.
Cited on intrusive trap sheets in Connecticut (W. M. Davis, '83, p. 294).
Cited on Marcou's geological map of North America (Marcou, '59).
Cited on mode of deposition of the Newark rocks of Pennsylvania (Frazer, '77*c*, p. 653).
Cited on *Mormolucoides articulatus* (Scudder, '84, p. 431).
Cited on origin of Newark estuaries (W. M. Davis, '83, p. 282).
Cited on origin of the red color of the Newark sandstone (Russell, '89, p. 49).
Cited on origin of the trap rock of Connecticut (Hovey, '89, p. 376).
Cited on relation of trap and sandstone in Massachusetts (W. M. Davis, '83, p. 286).
Cited on similarity in the trap rocks from Nova Scotia to South Carolina (How, '75, vol. 1, p. 136).
Cited on supposed fossil insect from Turner Falls, Mass. (E. Hitchcock, '58, p. 7).
Cited on trap rock (S. P. Merrill, '89, pp. 433, 434).
Table of geological formations by (Macfarlane, '79, pp. 8, 50).

DANA, SAMUEL L. [and EDWARD HITCHCOCK]. 1845.
Analysis of coprolites from the New Red sandstone of New England.
In Am. Jour. Sci., vol. 48, pp. 46–60.
Abstract in Neues Jahrbuch, 1848, pp. 368–369.
Gives result of analyses, and also a discussion based on the same.

DANBERRY, CHARLES. 1889.
Sketch of the geology of North America [etc., etc.].
Oxford [England]. Pp. i–xviii, 1–73.
Contains a brief sketch of the Connecticut valley. Pp. 19–23.

Danboro, Pa. Trap dikes near (Lewis, '85, p. 453).

Dan river area. Brief account of (Emmons, '57, p. 4).
Coal of. Brief account of (Patton, '88, p. 23).

Dan river area, N. C. Brief description of (Kerr, '75, p. 141).
Coal of (Kerr, '75, pp. 145, 295).
Fossils of (Kerr, '75, p. 147).
Section of (Emmons, '57, p. 12).
Section of Newark rocks in (Jones, '62, pp. 89–90).
Thickness of (Kerr, '75, p. 145).

Dan river area, Va. Boundaries and area of (Heinrich, '78, pp. 237–239).

Dan river coal field, N. C. Account of (McGehee, '83, pp. 75–77).
Brief account of (Daddow and Bannan, '66, pp. 403–404. Emmons, '52, pp. 144–153. C. H. Hitchcock, '74. Kerr, '66, pp. 45–46. Le Conte, '82, pp. 457–459).
Detailed description of (Emmons, '56, pp. 254–261).
Detailed report on (Chance, '85).

Dan river coal field, N. C.—Continued.
Economic importance, age, extent, etc. (Macfarlane, '77, pp. 526–528).
History of the commercial development of (Chance, '85, pp. 23–24).
Observations in (McLenahan, '52).
Section showing age of (Emmons, '56, p. 273).
Statistical account of (Anonymous, '69, p. 104).

Dan river coal field, Va., and N. C. Brief account of (Heinrich, '78, pp. 283–289).

Danville, Va. Boundary of the Newark near (W. B. Rogers, '39, p. 76).

Dark harbor, Grand Manan island, N. B. Dip of sandstone beneath trap at (Bailey, '72, p. 47).

Darlington, N. J. Course of trap ridge near (Nason, '89, p. 34).
Trap hill near (Cook, '82, pp. 48, 49).

Darnley, P. E. I. Remarks on structures near (Bain and Dawson, '85, p. 156).

Darnley basin, P. E. I. Section at (Dawson and Harrington, '71, pp. 18, 19).

DARTON, NELSON H. 1882.
Notes on the Weehawken tunnel [Bergen hill, N. J.].
In New York Acad. Sci., Trans., vol. 1, 1881–1882, pp. 129–131.
Describes certain minerals obtained from the locality referred to.

DARTON, NELSON H. 1882a.
On a new locality for hayesine and its novel occurrence.
In Am. Jour. Sci., 3d ser., vol. 23, pp. 458–459.
Abstract in Neues Jahrbuch, 1883 (2), p. 161.
Describes the occurrence of the mineral mentioned at Bergen hill, N. J., and gives an analysis of it.

DARTON, N. H. 1883.
On the disintegrated sandstone at New Durham, N[ew] J[ersey].
In New York Acad. Sci., Trans., vol. 2, 1882, 1883, pp. 117–119.
Describes an exposure of disintegrated sandstone at the west end of the Weehawken tunnel, Bergen hill, N. J., and gives several analyses of the sandstone, together with an analysis of the trap of Bergen hill, against which it rests.

DARTON, NELSON H. 1883a.
On the indurated shales between Bergen hill and the Palisades, N. J.
In the Scientific American supplement, vol. 16, pp. 6513–6514.
Describes in detail the structure at King Point near Hoboken, N. J.

DARTON, NELSON H. 1885.
On the occurrence of native silver in New Jersey.
In Am. Jour. Sci., 3d ser., vol. 30, pp. 80–81.
Describes the occurrence of native silver in the Bridgewater copper mine near Somerville, N. J.

DARTON, NELSON H. 1889.

On the great lava flows and intrusive trap sheets of the Newark system in New Jersey.

In Am. Jour. Sci., 3d ser., vol. 37, pp. 134–139.

The observations recorded embrace the whole of the Newark area of New Jersey. Concludes that the trap ridges of New Jersey were formed in part by extrusive and in part by intrusive sheets.

This is a preliminary publication of work reported more fully in U. S. Geol. Surv., Bull. No. 65, 1890.

DARTON, NELSON H. 1889a.

North American Geology for 1886.

In Smithsonian Inst., Ann. Rep. for year ending June 30, 1887, pp. 189–229.

Contains a review of investigations made in the Newark system in 1886, pp. 199–200.

DARTON, NELSON HORATIO. 1890.

The relations of the traps of the Newark system in the New Jersey region.

U. S. Geol. Surv., Bull. No. 67.

CONTENTS.

	Page.
Introduction	16
Watchung trap sheets	16
Structural relations in the Watchung region	16
Mutual relations of the Watchung traps	18
First and second Watchung traps	19
General relations	19
Thickness—faults	21
Columnar structure	23
Succession of sheets	24
The surface of the trap sheets and their contact relations with the inclosing strata	25
Third Watchung trap	32
General relations	32
Thickness	33
Rock structure	34
Relations to the associated sedimentary rocks	34
New Vernon trap	34
New Germantown trap	36
Palisade trap	37
General relations	37
Structural relations in the Palisade region	39
Faults	41
Thickness	44
Relations to underlying strata	45
Relations to overlying strata	50
Union hill trap	53
Granton trap	54
Snake hills trap	55
Arlington traps	56
Lawrence brook, Ten-mile run mountain, Rocky hill, Pennington mountain, Bald Pate, and Jericho hill traps	59
Sourland mountain trap	61
Trap of Cushetunk and Round mountains	62

DARTON, NELSON HORATIO—Continued.

	Page.
Small trap sheets in the Raritan river region	65
Martin Dock	65
New Brunswick	66
Flemington	66
Wertsville	67
Neshanic	67
Smaller trap masses of the Delaware river region	68
Point Pleasant	68
Belle mountain	68
Brookville	69
Blackwell mills	69
Hackensack	70
South Branch	70
Three Bridges	70
Stanton station	70
Summary	70
Bibliography	74
Index	80

DARTON, NELSON HORATIO. Cited on faults in the Newark rocks of New Jersey (Cook, '89, p. 14).

Cited on the structure of the Newark system (Cook, '87).

DARTON, NELSON H. and J. S. DILLER. 1890.

On the occurrence of basaltic dikes in the Upper Paleozoic series in central Appalachian region.

In Am. Jour. Sci., 3d ser., vol. 39, pp. 269-271.

Describes dikes of trap near Staunton, Va., which probably belong to system of dikes so largely developed in the Newark.

Petrographic notes by J. S. Diller.

Dauphin County, Pa. Brief report on (Lesley, '85, pp. XLV, XLVI, pl. 22).

Description of the Conewago hills in (Gibson, '20).

Davidson mill, N. J. Altered shale near (Cook, '68, pp. 213–214. Cook, '83, p. 23).

Altered shale near. used for building (Cook, '81, p. 55).

Trap boundary at (Cook, '68, p. 189).

DAVIS, CHARLES HENRY STANLEY. 1870.

[A sketch of the geology in the vicinity of Meriden, Conn.)

In history of Wallingford, Conn. [etc., etc.], by C. H. S. Davis, Meriden, Conn., pp. 36–53.

A popular sketch of the "physical history, geology, mineralogy, and mines" of the region mentioned.

DAVIS, CHAS. H. S. 1887.

The *Catopterus gracilis*.

In Meriden Sci. Assoc., Proc. and Trans., vol. 2, 1885–1886, pp. 19–22.

Contains an account of the occurrence of fossil fishes at Little Falls (Conn.), and a description of *Catopterus gracilis*.

DAVIS, W. M. 1881.

Illustrations of the earth's surface. Glaciers. Boston, folio, pp. 95–96.

See Shaler and Davis.

DAVIS, W. M. 1882.

Brief notice of observations on the Triassic trap rocks of Massachusetts, Connecticut, and New Jersey.

In Am. Jour. Sci., 3d ser., vol. 24, pp. 345–349.

Abstract in Neues Jahrbuch, 1884, pp. 231–232.

An account of a recent examination of the trap ridges in the regions referred to, with references to certain hypothesis proposed by previous writers concerning the origin of trap sheets, and the dip of the associated sedimentary beds. An announcement is made of new generalizations and hypothesis to account for the phenomena observed.

DAVIS, WILLIAM MORRIS. 1882a.

The structural value of the trap ridges of the Connecticut valley.

In Boston Soc. Nat. Hist., Proc., vol. 22, pp. 116–124.

Mentions the geographical extent of the Newark system. Considers the hypotheses that have been advanced to account for the uniform dip observed in certain of the Newark areas, and also the hypotheses concerning the former extent, especially of the Connecticut valley sandstone bed of the similar formation in New Jersey. Reasons are given for believing that many of the trap sheets of the Connecticut valley and of New Jersey are contemporaneous overflows and that they afford evidence of faulting and folding.

DAVIS, WILLIAM MORRIS. 1883.

On the relations of the Triassic traps and sandstones of the eastern United States.

In Museum of Comp. Zoöl., Bull., vol. 7, 1880–1884, pp. 249–309, pl. 9–11.

Reviewed by J. D. Dana in Am. Jour. Sci., 3d ser., vol. 25, pp. 474–475; and by G. H. Cook in Ann. Rep. Geol. of New Jersey, 1883.

Abstract in Science, vol. 1, p. 430; also in Neues Jahrbuch, 1884, pp. 230–232.

CONTENTS.

	Page.
Introduction	249–250
Bibliography	250–258
Observations on the Jura-Trias of the Connecticut valley and New Jersey	258–279
Nomenclature	258–259
Turner Falls, Mass	259–261
Mount Tom, Mass	261–263
West Springfield, Mass	263–264
Beckley, Conn	264–265
Meriden, Conn	265–266
Wallingford, Conn	266–267
New Haven, Conn	267–269
Fort Lee and Englewood, N. J	269–270
Weehawken, N. J	270–271
Jersey City, N. J	270–272
Paterson and Little Falls, N. J	272–274
Feltville, N. J	274–275

DAVIS, WILLIAM MORRIS—Continued.

Observations on the Jura-Trias of the Connecticut valley and New Jersey—Continued.

	Page.
Martin Dock, N. J	276–277
Lambertville, N. J	278–279
Brief statement of former views, with a pictorial supplement (pl. 9)	279–281
General discussion:	
Origin of the Triassic estuaries	282
Origin and deposition of the Triassic strata	283–284
Composition of the trap	284
Relation of the trap and sandstone	284–291
Trap dikes	291–293
Intruded trap sheets	293–297
Overflow trap sheets	297–300
Effect of the trap on the sandstone	300–302
Tilting of the sandstone and trap	302–307
First theory	302–303
Second theory	303
Third theory	303–304
Fourth theory	304–307
Summary	307–308
Explanation of plates	309

DAVIS, WILLIAM MORRIS. 1886.

The structure of the Triassic formation of the Connecticut valley.

In Am. Jour. Sci., 3d ser., vol. 32, pp. 342–352.

Reviews several hypotheses that have been advanced to account for the uniform easterly dip of the rocks of the Connecticut valley. Presents the results of exact observation in the same region, and advances a new hypothesis to account for the monoclinal structure in question.

DAVIS, WILLIAM MORRIS. 1888.

The structure of the Triassic formation of the Connecticut valley.

In Seventh Ann. Rep., U. S. Geol. Survey, 1885–1886, pp. 455–490, pl. 52.

Notice in Am. Geol., vol. 4, pp. 112–113.

CONTENTS.

	Page.
I. The conditions of the accumulation	461
Original area of deposit	461
Igneous rocks	462
Dikes	463
Intrusive sheets	463
Overflow sheets	464
Structural significance of overflows	466
Sequence and thickness of the Triassic series	467
Main trap overflow	467
Anterior trap overflow	468
Limestone	468
Posterior trap overflow	468
The Southbury-Woodbury Triassic area	468
II. The structure of the formation	469
General attitude	469
Classes of faults	469
Oblique faults	469
Strike faults	471

DAVIS, WILLIAM MORRIS—Continued.

II. The structure of the formation—Continued. Page.
Marginal faults................ 474
Systematic arrangement of faults... 474
Faults with reversed throw.......... 477
Folds of the crescentic ridges....... 477
Summary of structure to be accounted for 481
III. Mechanical origin of the Triassic monocline...................... 481
Conditions of the problem........... 481
Oblique deposition............ 481
Contemporaneous disturbance 482
Disturbance by intrusion 482
General tilting and faulting... 483
Relation of several Triassic areas........................ 483
Character of the disturbing force......................... 484
Action of compression on tilted schists.......................... 485
Formation of the faulted Triassic monocline 486
Origin of the crescentic ridges 488
Faults with reversed throw... 489

Some of the conclusions in reference to the origin of certain trap sheets in southern Connecticut, expressed in this papèr, are controverted by E. O. Hovey, '89.

DAVIS, W. M. **1888a.**

Remarks on the mechanical origin of the Triassic monoclinal in the Connecticut valley.

In Proc. Boston Soc. Nat. Hist., vol. 23, pp. 339–341.

Abstract in Am. Assoc. Adv. Sci., Proc., vol. 35, pp. 224–227.

Abstract of a paper, the substance of which is contained in "The Structure of the Triassic formation of the Connecticut valley." U. S. Geol. Surv., Seventh Ann. Rep., 1885–1886, pp. 455–490. Describes the prevailing structure of the sandstone of the Connecticut valley, and proposes an explanation of their monoclinal structure.

DAVIS, W. M. **1888b.**

The topographical map of New Jersey.

In Science, vol. 12, pp. 206–207.

In describing the topographic map published by the New Jersey geological survey the topography of the Newark area is briefly referred to, and suggestions made as to its origin.

DAVIS, WILLIAM MORRIS. **1889.**

The faults in the Triassic formation near Meriden, Conn. A week's work in the Harvard summer school of geology.

In Museum Comp. Zool., Harvard College, Bull., vol. 16, pp. 61–87, pls. 1–5.

A detailed study of the geological structure near Meriden. The divisions of the essay are: Cross-section of Lamentation mountain, pp. 61–64; cross-section of Shuttle meadow, pp. 64–69; the great fault west of Lamentation mountain, pp. 69–73; faults north of Lamentation mountain, pp. 73–76; faults in the Hanging hills, pp. 76–82, and north of West peak, pp. 82–85; review, pp. 85–86. Illustrated by sketch maps, views, and sections.

DAVIS, WILLIAM MORRIS. **1889a.**

The rivers and valleys of Pennsylvania.

In Nat. Geol. Mag., vol. 1, pp. 183–253.

Notice in Am. Geol., vol. 5, p. 60.

In discussing the origin of the relief of eastern Pennsylvania the denudation that preceded the deposition of the Newark system is referred to, and also the manner in which the Newark rocks were deposited. The origin of the monoclinal structure of the Newark system in New Jersey and Pennsylvania is briefly considered, as is also the denudation that preceded the deposition of the next succeeding system, pp. 194–198, 229–236. General distribution of high and low land and drainage in early Jurassic time is indicated on p. 233.

DAVIS, WILLIAM MORRIS. **1889b.**

The ash bed at Meriden and its structural relations.

In Meriden Sci. Ass., Proc. and Trans., vol. 3, 1887–1888, pp. 23–30.

Contains an account of an ash bed near Meriden, Conn., and a discussion of the structure of the Newark system of the Connecticut valley.

DAVIS, W. M. **1889c.**

Topographical development of the Triassic formation of the Connecticut valley.

In Am. Jour. Sci., 3d ser., vol. 37, pp. 423–434.

Itinerary of Harvard summer school of geology: Faults in the Meriden region; cross-section of the district; means of detecting the unfaulted sequence of Triassic beds; mechanism of monoclinal faulting; topographical development of the Triassic belt; initial constructional stages represented by the faulted blocks of southern Idaho. [Oregon]. Mountain ranges of the Great Basin, equivalent to a later Jurassic stage; the whole region base-leveled in late Cretaceous time; the present valley worn in the Cretaceous base-level plain after its elevation.

Polygenetic topography: The origin of the Connecticut river outlet via Middletown. The Connecticut river was originally consequent on the monoclinal faulting, and still persists near the course then taken, but has entered a second cycle of life as a result of the elevation of the lowland that was produced in the first cycle.

DAVIS, W. M. **1890.**

[Filling of fissures from above.]

In Geol. Soc. Am., Bull., vol. 1, p. 442.

DAVIS, W. M.—Continued.

In discussing a paper on sandstone dikes, by J. S. Diller, Davis describes certain fissures in trap at Meriden, Conn., which were filled from above.

DAVIS, WILLIAM MORRIS. **1891.**

The lost volcanoes of Connecticut.

In Pop. Sci. Mo., vol. 40, pp. 221-235.

Contains a popular account of certain beds of volcanic ash near Meriden, Conn., and shows that the ash was probably extruded from volcanoes that have since been removed by erosion.

DAVIS, W. M. Cited on the absence of contact metamorphism at Feltville, N. J. (Darton, '89, p. 135).

DAVIS, WILLIAM MORRIS. Cited on the faults in the Newark rocks of New Jersey (Cook, '89, p. 14).

Cited on the geology of Connecticut (Hovey, '89).

Cited on metamorphism (Russell, '89, p. 50).

Cited on the origin of the trap hills of Connecticut, etc. (Chapin, '87, p. 26).

Cited on the origin of the trap of Connecticut (Hovey, '89, pp. 375-376).

Cited on the origin of trap sheets near Meriden, Conn. (Nason, '89, p. 66).

Cited on the structure of the Newark system (Newberry, '88, pp. 6-7).

Cited on the structure of the Newark system in the Connecticut valley (Chapin, '89).

Cited on the structure of the Newark system and the origin of its trap sheets (Cook, '87).

Cited on trap at Feltville, N. J. (Darton, '90, p. 26).

Cited on the trap rocks of Connecticut (Marsters, '90).

DAVIS, W. M., and S. WARD LOPER. **1891.**

Two belts of fossiliferous black shale in the Triassic formation of Connecticut.

In Geol. Soc. Am., Bull., vol. 2, pp. 415-430.

CONTENTS.

	Page.
I. Introductory statement, by W. M. Davis	415
Previous studies	415
Structure of the Triassic formation about Meriden	416
Origin of the deposits	416
Formation of the trap sheets	417
Deformation	418
Subsequent degradation	419
Topographic expression of structure	419
Verification of inferences as to structure	421
II. Fossils of the anterior and posterior shales, by S. Ward Loper	425
The area examined	425
The localities explored	426
Anterior shales	426
Posterior shales	427
Species collected	428
Distribution of species	429

DAVIS, W. M., and S. WARD LOPER—Cont'd.

	Page.
II. Fossils of the anterior and posterior shales, etc.—Continued.	
Results	430
Discussion	430

DAVIS, W. M., and CHARLES LIVY WHITTLE. **1889.**

The intrusive and extrusive trap sheets of the Connecticut valley.

In Mus. Comp. Zool., Bull. Harvard College, vol. 16, pp. 99-138, pl. 1-5.

CONTENTS.

	Page.
Introduction	99-100
Means of distinguishing intrusions and extrusions	100-104
General features of intrusive and extrusive sheets in Connecticut	105-115
Group 1. Western trap ridges (Connecticut and New Jersey)	105-107
Group 2. Eastern trap ridges	107-115
Special account of the more important localities in Connecticut:	
Roaring Brook, Gaylord's mountain	116-118
The ash-bed in the Lamentation anterior	118-120
Hartford city quarry	120-122
Saltonstall mountain	122-127
Meriden quarry	127-133
Tariffville	133-135
Conclusion	135-136

DAVIS, W. M., and J. WALTER WOOD. **1889.**

The geographic development of northern New Jersey.

In Boston Soc. Nat. Hist., Proc., vol. 24, pp. 365-423.

Describes the effect of erosion on the Newark rocks of New Jersey and endeavors to determine the geological history of the region from a study of its drainage. Given sections illustrating the structure of the Newark terrane.

Davisburg, Pa. Dolerite, etc., from (C. E. Hall, '78, p. 35).

DAWSON, JOHN [WILLIAM]. **1845.**

On the newer coal formation of the eastern part of Nova Scotia.

In London Geol. Soc., Quart. Jour., vol. 1, pp. 322-330 and map.

The Newark system about the east end of basin of mines (Cobdequid bay) is shown in a general way on the map accompanying this paper.

DAWSON, JOHN WILLIAM. **1847.**

On the New Red sandstone of Nova Scotia.

In London Geol. Soc., Quart. Jour., vol. 4, pp. 50-59, pl. 5.

Describes exposures of the Newark system about the shores of Minas basin and Cobdequid bay, Nova Scotia. Mentions the relation of the sedimentary to the igneous rocks associated with them, and discusses briefly the conditions under which the sandstones and shales were deposited. The trap of Blomidon is considered as extrusive.

DAWSON, J. W. **1848.**

On the coloring matter of red sandstones and of grayish and white beds associated with them.

In London Geol. Soc., Quart. Jour., vol. 5, 1849, pp. 25-30.

Describes red and gray sandstones in Nova Scotia, chiefly Carboniferous, and discusses the origin of their colors.

DAWSON, J. W. **1848a.**

A handbook of the geology and natural history of Nova Scotia.

Pictou, Nova Scotia, 12mo.

Not seen.

DAWSON, JOHN WILLIAM. **1852.**

Additional notes on the red sandstones of Nova Scotia.

In London Geol. Soc., Quart. Jour., vol. 8, pp. 398-400.

Describes sections near the mouth of Petite river, in which a marked unconformity between Carboniferous and Newark rocks is exposed

DAWSON, J. W. **1853.**

Fossil saurian bones from Prince Edward island.

In Am. Jour. Sci., 2d ser., vol. 16, p. 283.

An abstract of an article published in the "Eastern Chronicle" of Nova Scotia, describing the discovery of *Bathygnathus borealis*.

DAWSON, J. W. **1854.**

On fossil coniferous wood from Prince Edward island.

In Philadelphia Acad. Nat. Sci., Proc., vol. 7, pp. 63-64.

Describes briefly the resemblance of certain rocks on Prince Edward island to the Newark system in Nova Scotia, and records the results of a microscopical examination of fossil wood from Gallas point, Des Sables, and other localities.

DAWSON, J. W. **1854a.**

[On the discovery and geological age of Bathygnathus borealis from Prince Edward island.]

In Philadelphia Acad. Nat. Sci.. Jour., 2d ser., vol. 2, 1850-1854, pp. 329-330.

Describes the rocks in which the fossil mentioned was found, and discusses their geological position.

DAWSON, J. W. **1856.**

On the parallelism of the rock formations of Nova Scotia with those of other parts of America.

In Am. Assoc. Adv. Sci., Proc., vol. 10, 1857, part 2, pp. 18-25.

Indicates briefly some of the leading characteristics of the Newark system in Nova Scotia and Prince Edward island. Pp. 20, 21.

DAWSON, JOHN WILLIAM. **1858.**

[A note relating to the age of the Newark system of North Carolina, Connecticut, etc., indicated by fossils obtained by E. Emmons in North Carolina.]

In Canadian Nat., 1st ser., vol. 3, p. 80.

Discusses briefly the probable age of the Newark system.

DAWSON, J. W. **1863.**

[Note on fossil plants from St. John county, New Brunswick.]

In Canadian Nat., vol. 8, pp. 259-260.

Brief note on fossil wood from near Gardner's creek, New Brunswick.

DAWSON, J. W. **1872.**

Notes on the geology of Prince Edward island, in the gulf of St. Lawrence.

In Geol. Mag., vol. 9, pp. 203-209.

This paper is essentially an abstract of Dawson and Harrington's report on the geological structure and mineral resources of Prince Edward island. See Dawson and Harrington, 1871.

DAWSON, J. W. **1872a.**

[The physical geography of Prince Edward island.]

In Canadian Nat., vol. 6, pp. 342-343.

Mentions the occurrence of sandstone above the upper coal formation, in which fossil plants and reptilian remains occur, considered of Triassic age.

DAWSON, J. W. **1873.**

The story of the earth and man.

New York, pp. i-ix, 1-403, and 12 plates.

Contains a popular account of the life of the Mesozoic ages, pp. 188-233.

DAWSON, JOHN WILLIAM. **1874.**

On the upper coal formation of eastern Nova Scotia and Prince Edward island in its relation to the Permian.

In London Geol. Soc., Quart. Jour., vol. 30, pp. 209-219.

The conformity of the Upper Carboniferous and so-called Newark beds on Prince Edward island is briefly stated, and also the evidence from fossil plants on which this generalization is mainly based. The views of Geinitz in reference to the Permian age of the newer red sandstone of Price Edward island are dissented from, pp. 209, 210, 217, 218.

DAWSON, J. W. **1874a.**

On the upper coal formation of eastern Nova Scotia and Prince Edward island, and its relation to the Permian.

In Geol. Mag., n. s., vol. 1, pp. 281-282.

States that the Carboniferous of Prince Edward island is overlain, apparently conformably, by the Newark system.

DAWSON [J. W.]. **1875.**

On the upper coal formation of eastern Nova Scotia and Prince Edward island, in its relation to the Permian.

In Canadian Nat., vol. 7, n. s., pp. 303-304.

From a study of the fossil plants contained in the younger sandstones of Prince Edward island the synchronism of these beds with the Permian of Europe is suggested. The name Permo-Carboniferous is proposed for these beds, which heretofore have been called Triassic.

DAWSON, JOHN WILLIAM. 1878.

Acadian Geology. The geological structure, organic remains, and mineral resources of Nova Scotia, New Brunswick, and Prince Edward island.

London, 3d ed., pp. i–xxvi, 1–687, pls. 1–9, and map, supplement, pp. 1–102, pl. 1.

Second edition. London, 1868, pp. i–xxvi, 1–694, pls. 1–9 and map. Pages and plates numbered the same as in 3d ed.

The first edition bears the following title: Acadian Geology: An account of the geological structure and mineral resources of Nova Scotia. Edinburgh, 1855, 12 mo., pp. i–xii, 1–388, pls. 1–5 and map.

Abstract in Neues Jahrbuch, 1855, pp. 333–337.

Reviewed in Edinburgh New Philosophical Journal, n. s., vol. 2, 1853, pp. 380–392; also in Canadian Jour., n. s., vol. 1, pp. 39–48.

The following is a table of contents of the third edition so far as it relates to the Newark system:

	Page.
Table of geological formations in the Canadian provinces, compared with those of Great Britain, United States, and Canada	19
Newark system of Nova Scotia	88–108
General description	86–87
General account of sedimentary rocks	87
General account of volcanic rocks	87–88
Description of outcrops near Truro and along the south side of Cobequid bay	88–90
Description of outcrops from Blomidon to Briar island	90–98
Description of outcrops from Truro to cape D'Or along the north side of Cobequid bay and Minas basin and channel	99–108
Newark system of New Brunswick	108–109
Quaco head, description of	108–109
Gardner's creek, description of	109
Salisbury cove, description of	109
Fossil plants, description of	108–109
Possible occurrence of coal	124
Grand Manan island, description of, by A. E. Verrill	679–680
Lignite at Martin's head (supplement)	99
General remarks on the Newark of Nova Scotia and New Brunswick	109–113
Minerals of the Newark sandstone and trap	113–116
Newark system of Prince Edward island	116–124
Description of Prince Edward island	116
Age of sandstones	116–117
Fossil plants (supplement, 30)	117–118
Fossil reptiles	119–122

DAWSON, JOHN WILLIAM—Continued.

Newark system of Prince Edward island—Continued.

	Page.
Useful minerals	123
Soils	123
Possible occurrence of coal	123–124
Conformability of Newark and Carboniferous	123–124
Separation of Newark and Carboniferous areas (supplement)	28–29
Thickness (supplement)	29
Sections (supplement)	31
Passage of Newark into Carboniferous (supplement)	32, 33

DAWSON, JOHN WILLIAM. 1878a.

Supplement to the second edition of Acadian Geology, containing additional facts as to the geological structure, fossil remains, and mineral resources of Nova Scotia, New Brunswick, and Prince Edward island.

In Acadian Geology, 3d ed., pp. 1–102, pl. 1.

Reviewed in Canadian Nat., vol. 8, pp. 472–475.

This supplement is bound with the third edition of the Acadian Geology, and contains new observations relating to the classification of the rocks of Prince Edward island, and indicates the difficulty of separating the Newark and Carboniferous, pp. 28–31. The fossils of the Newark on Prince Edward island are briefly discussed, p. 30. The occurrence of lignite at Martin's head, N. B., is noticed on p. 99.

DAWSON, WILLIAM. 1885.

Notes on the geology and fossil flora of Prince Edward island (see Bain and Dawson, 1885).

DAWSON, JOHN WILLIAM. 1887.

Presidential address: Some points in which American geological science is indebted to Canada.

In Canada Roy. Soc., Proc. and Trans., vol. 4, sec. 4, 1886, pp. 1–8.

Contains a brief historical reference to the study of the Newark system in Canada.

DAWSON, J. WILLIAM. 1888.

The geological history of plants.

New York (The International Scientific Series), pp. i–viii, 1–290.

Contains a popular account of the early Mesozoic floras, pp. 175–190.

DAWSON, J. WILLIAM. 1888.

On the Eozoic and Paleozoic rocks of the Atlantic coast of Canada in comparison with those of western Europe and of the interior of America.

In Quart. Jour. Geol. Soc., London, vol. 44, pp. 797–817.

States briefly that the rocks of the Newark system in Canada resemble the Triassic rocks of Europe. They contain no important marine limestones, and their fossils are limited to a single Dinosaurian reptile and a few plants. The flora and land and fresh water faunas seem to have been of southern origin, p. 815.

DAWSON [J. W.]. Cited as to the relations of trap and sandstone in Nova Scotia (W. M. Davis, '83, p. 285).

Cited on the age of the Newark system (Lea, '58).

Cited on the age of the red sandstone of Nova Scotia (Jackson, '50, p. 338).

Cited on the discovery of Bathygnathus on Prince Edward island (Owen, '76, p. 361).

Cited on the geology of cape Blomidon, N. S. (Marsters, '90).

Cited on the geology of Prince Edward island (Bain and Dawson, '85, pp. 156, 157).

Cited on the overflow trap sheets in Nova Scotia (W. M. Davis, '83, p. 297).

Cited on the tilting of sandstone and trap in Prince Edward island (W. M. Davis, '83, p. 302).

Cited on trap dikes in Prince Edward island (W. M. Davis, '83, p. 291).

Notice of work done by, in Nova Scotia, etc. (Miller, '79-'81, vol. 2, pp. 151, 152, 158-161, 223).

DAWSON, JOHN WILLIAM, and B. J. HARRINGTON. 1871.

Report on the geological structure and mineral resources of Prince Edward island.

Montreal [Can.]: Pp. 1-51, pls. 1-3, together with a geological map (frontispiece) and one plate of sections.

Abstract in Neues Jahrbuch. 1872, pp. 439-441; also in Am. Jour. Sci., 3d ser., vol. 3, p. 222.

Contains a description of the character and extent of the red sandstones, red and mottled clays, calcareous sandstones and conglomerates, arenaceous limestones, dolomite and trap of the Newark system on Prince Edward island, pp. 13-22. Also a number of measured sections (pp. 33-34, and an account of the building stones and water supply. Analyses of limestones are given on page 41, and an account of fossils, comprising descriptions of fossil wood and fucoids; and remarks on a reptile, *Bathygnathus borealis*, pp. 45, 46.

Nearly all of the rocks described in this report as Triassic have been referred to the Carboniferous by later observers. See supplement to the second edition of Acadian Geology, by J. W. Dawson, London, 1878, pp. 32-33; Geol. Surv. Canada, Rep. of Progress for 1882-1883-'84, p. 16E; and a note on the margin of map No. 5 S W, which accompanies this report.

Day's point, N. J. Dip at (Russell, '80, p. 47).

Section at, showing junction of trap with sedimentary rocks beneath (Russell, '80, p. 47).

Dead swamp, Conn. Description of trap ridges near (Percival, '42, p. 374).

DEANE, JAMES. 1842.

[Notice of the footprints of birds in the New Red sandstone of Connecticut.]

In London Geol. Soc., Proc., vol. 4, p. 22.

Describes very briefly some newly found bird tracks, rain marks, and other impressions in the red sandstone of Connecticut.

DEANE, JAMES. 1843.

[A letter to G. A. Mantell relating to the fossil footprints of the Connecticut valley.]

In Am. Jour. Sci., vol. 45, pp. 177-188.

Contains a general description of certain footprints, and compares some of the fossil tracks with the tracks of living birds. Published by B. Silliman in a paper entitled Ornithichnites of the Connecticut river sandstones and the Dinornis of New Zealand.

DEANE, JAMES. 1844.

On the fossil footmarks of Turners Falls, Massachusetts.

In Am. Jour. Sci., vol. 46, pp. 73-77, pls. 1, 2.

Abstract in Neues Jahrbuch, 1844, pp. 635-637.

Gives a general description of certain footprints found at the locality mentioned.

DEANE, JAMES. 1844a.

On the discovery of fossil footmarks.

In Am. Jour. Sci., vol. 47, pp. 381-390.

Relates to priority in the discovery of fossil footprints in sandstone of the Connecticut valley.

DEANE, JAMES. 1844b.

Answer to the "Rejoinder" of Prof. Hitchcock.

In Am. Jour. Sci., vol. 47, pp. 399-401.

Relates to the question of priority in the discovery of fossil footprints in the sandstone of the Connecticut valley.

DEANE, JAMES. 1848.

Fossil footprints of a new species of quadruped.

In Am. Jour. Sci., 2d ser., vol. 5, pp. 40-41.

Abstract in Neues Jahrbuch, 1851, p. 497.

Describes and illustrates the tracks of a quadruped discovered in the sandstone at Turners Falls, Mass.

DEANE, JAMES. 1845.

Description of fossil footprints in the New Red sandstone of the Connecticut valley.

In Am. Jour. Sci., vol. 48, pp. 158-167, pl. 3.

Describes four and five toed footprints near Turners Falls, Mass.

DEANE, JAMES. 1845a.

Notice of a new species of Batrachian footprint.

In Am. Jour. Sci., vol. 49, pp. 79-81.

Abstract in Am. Assoc. Geol. and Nat., Proc., 6th meeting, p. 25.

Describes and figures the footprints of a quadruped found in the Connecticut valley sandstone.

DEANE, JAMES. 1845b.

Fossil footmarks and raindrops.

In Am. Jour. Sci., vol. 49, pp. 213-215.

Describes the tracks of "birds" and "batrachians" found at Turners Falls, Mass., and gives a figure of a slab of sandstone with several series of tracks.

DEANE, JAMES. 1845c.

Illustrations of fossil footmarks.

In Boston Soc. Nat. Hist., Proc., vol. 2, p. 32.

A notice of the presentation of a paper on the above title to the society.

DEANE, JAMES. 1845d.
Illustrations of fossil footmarks.
In Boston Jour. Nat. Hist., vol. 5, pp. 277–284, pl. 23.
Gives a general description of certain fossil footprints from the Connecticut valley.

DEANE, JAMES. 1847.
Notice of new fossil footprints.
In Am. Jour. Sci., 2d ser., vol. 3, pp. 74–79.
Abstract in Neues Jahrbuch, 1849, pp. 379–381.
Describes three, four, and five toed tracks found at Turners Falls, Mass.

DEANE, JAMES. 1847a.
[Note on fossil footprints from Turners Falls, Mass.]
In Am. Jour. Sci., 2d ser., vol. 4, pp. 448–449.
Refers to the claim of a certain series of tracks to be regarded as belonging to a new species.

DEANE, JAMES. 1849.
Illustrations of fossil footprints of the valley of the Connecticut.
In Am. Acad., vol. 4, pp. 209–220, pls. 1–9.
Presents general description, with figures, of a large number of footprints from the Connecticut valley. The matter contained in this paper is incorporated in Deane's later and larger work "Ichnographs from the sandstones of the Connecticut river," 1861.

DEANE, JAMES. 1850.
Fossil footprints of Connecticut river.
In Philadelphia Acad. Nat. Sci. Jour., 2d ser., vol. 2, 1850–1854, pp. 71–74, pls. 8, 9.
A general description of fossil footprints from Turners Falls, Mass.

DEANE, JAMES. 1856.
On the sandstone fossils of the Connecticut river.
In Philadelphia Acad. Nat. Sci. Jour., 2d ser., vol. 3, 1855–1858, pp. 173–178, pls. 18–20.
Abstract in Neues Jahrbuch, 1857, pp. 877–878.
Gives a general description of several footprints, both vertebrate and invertebrate, from Turners Falls, Mass.

DEANE, JAMES. 1861.
Ichnographs from the sandstone of Connecticut river.
Boston, 4to, pp. 1–61, pls. 1–46.
Notice in Am. Jour. Sci., 2d ser., vol. 36, pp. 126–127.

CONTENTS.

	Page.
Introduction, by Austin A. Gould	3–4
Biographical notice [of James Deane], by Henry I. Bowditch	5–12
List of [James Deane's] published papers	13–14
Note on the preparation of the plates, by T. T. Bouvé	17
Literary history of the footprints	19–20
Analysis of the footprints	20–26
Footprints in situ	26–29
Causes that have prevented the perfect preservation of the footprints	29–31

DEANE, JAMES—Continued. Page.

Probable sources of the waters of the sandstone basin	31–32
Classification of the footprints	32
Description of the plates	35–61

Plates No. 1 and 2 represent footprints of living animals for comparison with the fossil tracks. Plates 3–44 represent fossil footprints and trails. Plate 45, photograph of recent raindrop impressions for comparison; pl. 46 is a photograph of raindrop impressions on sandstone. In the text accompanying the plates no attempt is made to give a scientific description of the various tracks, but in some instances they are identified with the genera and species described by Edward Hitchcock in his Ichnology of New England.
Plates 3–15, 18–30, 32–39, 42 were drawn on stone from nature by James Deane. Pls. 16–17, 31, 40–41, 43–46 are photographs.

DEANE, [JAMES]. Cited on Anomœpus major (E. Hitchcock, '65, p. 37, pl. 19).
Cited on fossil footprints (Murchison, '43).
Cited on fossil footprints from the Connecticut valley (Gray and Adams, '60, pp. 247–252. E. Hitchcock, '44*a*, p. 305. Lea, '53, pp. 185, 189. Lyell, '66, p. 454. Lyell, '71, p. 362. Owen, '59, pp. 181, 325. Pictet, '53, vol. 1, p. 407).
Cited on fossil footprints from Turners Falls, Mass. (Mantell, '46. Winchell, '70, p. 183).
Cited on fossil footprints near Turners Falls, Mass. (E. Hitchcock, '43*a*, p. 254).
Cited on fossil plant from Montague, Mass. (E. Hitchcock, '43*b*, p. 296, pl. 12).
Cited on number of joints in the toes of fossil footprints (Silliman and Dana, '47).
Cited on the number of phalanges in the toes of birds (Silliman, Silliman, jr., and Dana, '47).
Cited on priority in description of footprints (E. Hitchcock, '58, pp. 192, 196).
Credited with the early discovery of footprints in the Connecticut valley (H. D. Rogers, '44, pp. 249–250).
Discovery of fossil footprints by (E. Hitchcock, '58, p. 4).

Dean's, N. J. Trap outcrops at (Cook, '82, pp. 59–60).

Dean's Pond, N. J. Boundary of Newark at (Cook, '68, p. 176).
Section from, to Bloomsburg, N. J. (Cook, '68, p. 199, and map in portfolio).
Trap boundary at (Cook, '68, p. 189).
Trap hills near (Cook, '68, pp. 189–190).

Debert river, N. S. Coal measures at, overlain by New Red sandstone (Gesner, '43).
Description of (Dawson, '78, pp. 99–100).
Dip of the Newark near (Ells, '85, p. 43E).
Section at (Dawson, '47, p. 51, pl. 5).

Deep river, N. C., and Richmond, Va., coal fields. Compared (Emmons, '56, pp. 338–342).

Deep river coal field, N. C. Age of, as indicated by fossil fishes (Agassiz, '53).

Deep river coal field, N. C.—Continued.
- Analyses of coal from (W. R. Johnson, '51*a*. Kerr, '75, pp. 293–295).
- Account of (J. D. Dana, '75, p. 406. Emmons, '52, pp. 116–143).
- Account of, with analysis (Chance, '84).
- Account of the coal of (Patton, '88, p. 25).
- Brief account of (Daddow and Bannan, '66, pp. 404–406. Emmons, '57, p. 4. C. H. Hitchcock, '74. Jackson, '53. Kerr, '66, pp. 45–46. Kerr, '75, p. 141. LeConte, '82, pp. 457–459. Lyell, '54, p. 12. Lyell, '66, p. 457. McGehee, '83, pp. 75–77. W. B. Rogers, '53).
- Coal from, character and efficiency of (W. R. Johnson, '50, pp. 133–134, and table op. p. 134).
- Coal of (Kerr, '75, pp. 142–143).
- Coal, discovery of (Olmstead, '20).
- Commercial value and quality of coal from (Chance, '85, pp. 50–56).
- Description of (W. R. Johnson, '50, pp. 161–166).
- Detailed description of (Emmons, '56, pp. 227–256).
- Economic importance, extent, age, etc. (Macfarlane, '77, pp. 518–526).
- Explorations for coal in (Chance, '85, pp. 25–50).
- Fossils of (Kerr, '75, p. 147).
- Influence of trap on coal in the (Wilkes, '58, p. 7).
- Iron ore of (Willis, '86, p. 306).
- Map of (Emmons, '56, pp. 338–342).
- Map of, after Wilkes and Emmons (Chance, '85).
- Method of development of (Chance, '85, pp. 60–62).
- Observations in (McLenahan, '52).
- Obstruction to successful mining in (Chance, '85, pp. 58–60).
- Report on (W. R. Johnson, '51. Olmstead, '24. Wilkes, '58).
- Report on, detailed (Chance, '85).
- Sandstone of (Kerr, '75, p. 304).
- Search for coal in (Jackson, '56*a*).
- Section at Egypt (Kerr, '75, p. 242).
- Section in, general (Jones, '62, pp. 89–90).
- Section showing age of (Emmons, '56, p. 273).
- Statistical account of (Anonymous, '69, p. 104).
- Thickness of (Kerr, '75, p. 145).
- Workable area of (Chance, '85, pp. 56–58).

Deep river coal field, Va. Account of (Macfarlane, '77, p. 505).
- Brief statement of the geology of (Chance, '85, pp. 19–22).
- History of the commercial development of (Chance, '85, pp. 23–24.)

Deep run, Va. Analysis of coal from (Clifford, '87, p. 10. De La Beche, '48, p. lxv. Macfarlane, '77, p. 515. Williams, '83, p. 82).
- Condition of coal mines at (Clifford, '87, p. 2).
- Description of (Wooldridge, '42, p. 13).
- Fossil crustaceans from (Jones, '62, p. 86).
- Fossil plants from (Fontaine, '83, p. 4).

Deep run, Va.—Continued.
- Map and section of (Clifford, '87, pl. 5).
- Notes on (Taylor, '35, pp. 284–292).
- Note on faults in (Taylor, '35, p. 292.)
- Reference to (W. B. Rogers, '40, p. 72).
- Section of (Clifford, '87, pp. 24–25, pl. 5).
- Trial of the coal of, for heating purposes (W. R. Johnson, '44, pp. 309–324, 448).

Deerfield, Mass. Amygdaloid trap in (E. Hitchcock, '23, vol. 6, pp. 52–54).
- Brief account of geology of (E. Hitchcock, '18, pp. 105, 108).
- Building stone quarried in (E. Hitchcock, '41, p. 180).
- Columnar trap in (E. Hitchcock, '35, p. 402).
- Conglomerate in (E. Hitchcock, '35, p. 214).
- Conglomerate near, note on (Nash, '27, p. 247).
- Conglomerate with graphic granite at (E. Hitchcock, '41, p. 441).
- Description of footprints from (E. Hitchcock, '36, pp. 320–325).
- Description of fossil footprints from (E. Hitchcock, '58).
- Dip at (E. Hitchcock, '35, p. 223).
- Dip and strike of rocks in (E. Hitchcock, '41, p. 448).
- Early discovery of fossil footprints at (E. Hitchcock, '36, p. 308).
- Fossil fishes found at (E. Hitchcock, '35, p. 238, pl. 14 in atlas).
- Fossil fishes from, account of (E. Hitchcock, '41, p. 458).
- Fossil fishes from, remarks on (Harlan, '34, pp. 92–94).
- Fossil fish, reference to a locality for (J. H. Redfield, '36).
- Fossil plants at, notice of (E. Hitchcock, '35, p. 235).
- Fossil plants from (E. Hitchcock, '41, p. 456).
- General description of trap ridges near (E. Hitchcock, '41, p. 648).
- Grindstones quarried in (E. Hitchcock, '41, p. 213).
- Gypsum at (E. Hitchcock, '35, pp. 54, 213).
- Localities of fossil footprints in (E. Hitchcock, '41, p. 467).
- Locality of fossil footprints in (E. Hitchcock, '43*a*, p. 262).
- Occurrence of minerals at (Silliman, '18*a*).
- Trap near, brief account of (E. Hitchcock, '23, pp. 46–48).
- Trap near, remark on (E. Hitchcock, '23, vol. 6, p. 60).
- Trap range near, discussion of the geological structure of (W. M. Davis, '86).
- Trap ridges near, account of (E. Hitchcock, '35, p. 409).

Deerfield dike, Mass. Description of (Emerson, '82).
- Mineralogy of (Emerson, '82).

Deerfield mountain, Mass. Character of rock at (E. Hitchcock, '41, p. 447).
- Description of (E. Hitchcock, '41, p. 248).
- Description of geology of (W. M. Davis, '83, p. 259).
- Description of scenery near (E. Hitchcock, '23, vol. 7, p. 10).

Deerfield mountain, Mass.—Continued.

Dip at (E. Hitchcock, '35, p. 223).

Dip and strike of rocks at (E. Hitchcock, '41, p. 448).

Formed by an overflow trap sheet (W. M. Davis, '88, p. 464).

Structure of (W. M. Davis, '88).

Thickness of Newark system at (E. Hitchcock, '35, pp. 224–225).

Trap rock of, account of (E. Hitchcock, '41, pp. 641–643).

DE KAY, JAMES E. **1842.**

[A list of the fossil fishes of the United States.]

In Nat. Hist. N. Y., part 1, Zoology, pp. 385–386.

Includes a list, with localities, of fossil fishes from the Newark rocks of New Jersey and Connecticut valley.

DE KAY, [L.]. Cited on fossil fish from Connecticut (J. H. Redfield, '36).

Cited on the early discovery of fossil fishes in the Newark system (Newberry, '88, p. 19).

DE LA BECHE, HENRY T. **1848.**

Anniversary address (before the Geological Society of London).

In London Geol. Soc. Quart. Jour., vol. 4, pp. xxi–cxx.

Contains a digest of the observations of C. Lyell and C. J. F. Bunbury in the Richmond area, pp. xxx, xxxi, xlvi, xlviii, lxiv-lxvii.

DE LA BECHE. Cited on fossil plants from Massachusetts (E. Hitchcock, '35, p. 235).

Delanys quarry, Mass. Contact of sandstone and trap at (W. M. Davis, '83, p. 262).

Delaware river, N. J. Sandstone quarries near (Shaler, '84, p. 143).

Dennis bridge, N. C. Section near (W. R. Johnson, '51, p. 5).

Derby, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 416–417).

DESOR, [E.]. **1849.**

[Comparison of a recent footmark with certain footmarks in the red sandstone of the Connecticut valley.]

In Boston Soc. Nat. Hist., Proc., vol. 3, p. 202.

The impressions left on sand by the tarsal bone of certain birds, as well as the imprint made in some instances by the hind toe and the furrows made by the dragging of the toes, are briefly described and compared with what are considered similar impressions on sandstone.

DESOR, [E.]. **1851.**

[Remarks on fossil raindrop impressions and on similar markings produced by air bubbles in sand.]

In Am. Assoc. Adv. Sci., Proc., vol. 5, p. 74.

Suggests that many so-called raindrop impressions may have been produced by the escape of air bubbles from wet sand.

DESOR, [E.]. **1851.**

[Raindrop impressions and markings made by air bubbles.]

DESOR, [E.]—Continued.

In Am. Assoc. Adv. Sci., Proc., vol. 5, p. 79.

Discussion of a paper by W. C. Redfield.

DESOR, [E.]. **1851a.**

[Concerning fossil raindrop impressions.]

In Boston Soc. Nat. Hist., Proc., vol. 4, pp. 131–132.

Admits the possibility of the occurrence of rainmarks in some formations, but contends that the bursting of bubbles in the sand and mud of a shore would account for such impressions as are supposed to have been made by raindrops in the Connecticut valley sandstone.

DESOR, [E.], and [J. D.] WHITNEY. **1849.**

[Observations on the probable origin of the so-called fossil raindrop impressions on sandstones.]

In Boston Soc. Nat. Hist., Proc., vol. 3, pp. 200–201.

The formation of depressions resembling raindrop impressions, by the breaking of air bubbles in sand, is described and the similarity of such marks to fossil raindrop impressions pointed out.

Des Sables, P. E. I. Description of fossil wood from (Dawson, '54).

Devils bridge, Va. Boundary of Newark area near (Heinrich, '78, p. 231).

Devils den, Pa. Analysis of trap from (Frazer, '77, p. 310).

Picture of (Frazer, '80, pl. 9).

Specimens of trap from (C. E. Hall, '78, p. 27).

Devon Inn, Pa. Trap dike near (Lewis, '85, p. 444).

Diabase. See Trap.

DICKESON, MONTROVILLE WILSON. **1859.**

Report on the geological survey and condition of the Hunterdon Copper Company's property, Hunterdon County, New Jersey. Accompanied by a report by E. and C. H. Hitchcock.

Philadelphia, pp. 1–23.

Contains a record of dips, interstratified trap and shale, character of ore, etc., pp. 5, 8, 10. Accompanying this report is a brief report, p. 20, on the same mine by E. and C. H. Hitchcock.

DIGBY, N. S. Iron ore near (Jackson and Alger, '33, pp. 235–236).

Iron ores near, note on (Alger, '27, p. 231).

Rock near (Jackson and Alger, '33, pp. 235–238).

Trap dikes near (Dawson, '78, p. 95).

Digby gut, N. S. Description of (Gesner, '36, pp. 185–187).

Erosion resulting from (Russell, '78, p. 221).

Mode of formation (Gesner, '36, pp. 186–187).

Sandstone beneath trap at (Dawson, '78, p. 95).

Submerged ledges near (Perley, '52, p. 159).

Specific gravity of trap rocks from (How, '75, vol. 1, p. 138).

(See Annapolis gut.)

Digby neck, N. S. Amygdaloid beneath trap at (Gesner, '36, p. 175).

Description of (Dawson, '78, pp. 95–96. Gesner, '36, p. 175).

Digby neck, N. S.—Continued.
Iron ore in trap at (Alger, '27, pp. 229–330).
Rocks near (Gesner, '36, pp. 71–72, 74).
Sandstone beneath trap at (Dawson, '78, p. 98).

D[EWEY], C. 1857.
[Review of the geological report of the Midland counties of North Carolina, by E. Emmons, accompanied by a letter on the age of the coal-bearing strata of North Carolina, by O. Heer.]
In Am. Jour. Sci., 2d ser., vol. 24, pp. 427–429.
Gives a brief review of Emmons's report, and publishes extended extracts from a letter by O. Heer on the fossil plants of the Newark system, in which the age of the system is critically considered. This letter is published in part also in J. Marcou's geology of North America, Zurich, 1858.
Following the review are "Additional remarks" by J. D. Dana.

Dikes changing to intruded sheets in Connecticut (Percival, '42, p. 300).
General account of (J. D. Dana, '73, vol. 6, pl. 106. J. D. Dana, '75, p. 421. Jackson, '56).
In Alabama, reference to (E. A. Smith, '78, pp. 139, 142).
In Connecticut, mention of (Percival, '42, p. 307).
In Connecticut valley, brief account of (W. M. Davis, '88, p. 463).
Discussion concerning (Whelpley, '45, p. 63).
Mention of (J. D. Dana, '75*a*, p. 498).
Near Deerfield, Mass. (Emerson, '82).
East Haven, Conn. (W. M. Davis, '83, pp. 305–307, pl. 10).
Holyoke, Mass. (Emerson, '82).
Meriden, Conn. (J. D. Dana, '70).
Meriden, Conn. (W. M. Davis, '89, p. 62).
New Haven, Conn. (J. D. Dana, '71, pp. 46–47).
New Haven, Conn. (Danbury, '39, pp. 22, 23).
New Haven, Conn. (W. M. Davis, '83, pp. 305–307, pl. 10).
Wallingford, Conn. (Chapin, '35).
Section showing the supposed character of (W. M. Davis, '86, p. 350).
In Massachusetts, brief account of (E. Hitchcock, '35, pp. 414–418).
In New Jersey (Darton, '89, pp. 138–139).
In North Carolina, brief notice of (Mitchell, '42, p. 39).
Deep river area (Chance, '85, p. 59).
In Pennsylvania, connection with faults (Lesley, '83, p. 181).
Frequency of (Lesley, 83, p. 181).
In Vermont, brief account of (Adams, '46, pp. 160–162).
In Virginia, detailed account of (W. B. Rogers, '39, pp. 81–83. W. B. Rogers, '40, pp. 64–69).
In Richmond area (Stevens, '73).
Near Staunton, description of (Darton and Diller, '90).
Near Warren, metamorphism produced by (W. B. Rogers, '39, pp. 82–83).
Strike of (W. B. Rogers, '39, p. 82).
Of Connecticut, topographic form of (Percival, '42, p. 300).

Dikes—Continued.
Of greenstone (trap) in Connecticut, an account of (E. Hitchcock, '41, pp. 655–656).
Of indurated clay in Connecticut (Percival, '42, p. 448. A. Smith, '32, pp. 225–226).
Of trap in Connecticut valley, relation of, to other trap systems (Jackson, '45).
Of trap in Connecticut, detailed description of (Percival, '42, pp. 299–426).
Of trap in Connecticut (southern), description of (Hovey, '89).
Of trap in Deep river, N. C., coalfield, changes produced by (Emmons, '56, p. 254).
In Georgia, brief account of (Henderson, '85, p. 88. T. P. James, '76, p. 38 and map).
In Georgia (Loughridge, '84, p. 279).
In New Hampshire, probable age of (Hubbard, '50, p. 170).
In New Jersey (Cook, '68, p. 204. Darton, '90).
In New York (Darton, '89, '90).
Brief account of (Emmons, '84, pp. 16–17).
Brief account of, in Rockland county (Lincklaen, '61, p. 35. Mather, '39, pp. 117, 122).
In North Carolina, brief account of (Henderson, '85, p. 88).
In Nova Scotia, brief account of (Marsters, '90).
Mention of (Honeyman, '85, p. 123).
In Pennsylvania, at Cornwall, an account of (Invilliers, '86*a*, pp. 876–879).
At Flourtown (C. E. Hall, '81, p. 75).
At Marble Hall (C. E. Hall, '81, p. 75).
At New Hope, mention of (H. D. Rogers, 48).
At Williamson Point, a study of the chemical and optical character of (Frazer, '78).
In Lancaster county, general remarks on (Frazer, '80, p. 27–31).
In Pennsylvania, mention of (Lesley, '83, p. 211).
In York county, brief account of (Frazer, '85, p. 404).
In South Carolina (Henderson, '85, p. 88).
Description of (Tuomey, '44).
On Prince Edward island (Chapman, '76, p. 92).

Diligence river, N. S. Rocks of (Jackson and Alger, '33, p. 279).

DILLER, J. S. 1890.
Notes on the petrography [of basaltic dikes near Staunton, Va.].
See Darton and Diller, 1890.

Dillsburg, Pa. Analysis of iron ore from near (Frazer, '77, pp. 232–237).
Analysis of limestone from (Frazer, '76*c*, p. 63. Frazer, '77, p. 308. McCreath, '81, pp. 79–80).
Boundary of the Newark near (Frazer, '82, p. 123).
Conglomerate near (H. D. Rogers, '58, vol. 1, p. 204. H. D. Rogers, '58, vol. 2, p. 683).
Contact metamorphism near (H. D. Rogers, '58, vol. 2, p. 689).
Iron ore mines near, description of (d'Invilliers, '86, pp. 1501–1514).
Iron ores and trap dikes near, discussion concerning (Frazer, '77, pp. 317–371, pl. op. p. 328).

Dillsburg, Pa.—Continued.
- Iron ores near (Frazer, '82, pp. 135–139).
- Iron ores near, a study of the (Frazer, '76*d*).
- Iron ores near, references to (Lesley and d'Invilliers, '85, p. 599).
- Junction of the Newark and the valley limestone (H. D. Rogers, '58, vol. 1, p. 204).
- Reports on mines near (Frazer, '77, pp. 207–240).
- Rock specimens from near, mention of (C. E. Hall, '78, p. 28–70).
- Section from, to Beller crossroads (Frazer, '77, pp. 265–273, pl. op. p. 264).
- Trap, association of magnetite with, at (Frazer, '80, p. 27).
- Trap dike near (H. D. Rogers, '58, v. 2, p. 689).
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- Influence of dikes on (Percival, '42, p. 320).
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- Beneath trap (E. Hitchcock, '58).
- Brief statement concerning (Percival, '42, pp. 430–431).
- Origin of (W. M. Davis, '82*a*, pp. 123–124. E. Hitchcock, '35, p. 518. E. Hitchcock, '41, pp. 527–529. E. Hitchcock, '53. E. Hitchcock, '58, p. 13. E. Hitchcock, '58, p. 14–17. E. Hitchcock, '63. Silliman, jr., '42. Silliman, jr., '42*a*. Silliman, jr., '44. A. Smith, '32, pp. 223–224. Whelpley, '45, pp. 61–62. Whitney, '60).
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- Mount Holyoke (E. Hitchcock, '35, p. 417. E. Hitchcock, '41, p. 654).
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- At Cape Tormentin (Dawson, '78, p. 124).
- Dark harbor (Bailey, '72, p. 47).
- Gardners creek (Mathew, '63, p. 256).
- Grand Manan island (Bailey, '72, pp. 45–47. Verril, '78).
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- Salisbury cove (Dawson, '78, p. 109. Matthew, '65, p. 124).

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- Arlington (Russell, '78, p. 223).
- Belleville (Cook, '81, p. 44).
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- Chatham (H. D. Rogers, '40, p. 133).
- Closter landing (Cook, '68, p. 200).
- Days point (Russell, '80, p. 47).
- East Bloomfield (H. D. Rogers, '40, p. 130).
- Englewood (W. M. Davis, '83, p. 269).
- First mountain (Cook, '82, p. 50).
- Greensburg (Cook, '81, pp. 57–58).
- Hopewell (Cook, '68, p. 709).
- Hudson river (Russell, '80, p. 47).

- **Dip in New Jersey**—Continued.
  - Hunterdon mine (Dickeson, '59, pp. 8, 10).
  - Jefferson (H. D. Rogers, '40, pp. 129–130).
  - Kings point (Darton, '83*a*).
  - Little Falls (Cook, '81, p. 50. H. D. Rogers, '40, p. 131).
  - Long hill (H. D. Rogers, '40, p. 132).
  - Milford (Cook, '68, p. 521. Cook, '81, p. 64. H. D. Rogers, '36, p. 147. H. D. Rogers, '40, p. 140. Shaler, '84, p. 144).
  - Newark (Cook, '81, p. 48. H. D. Rogers, '40, p. 130. Russell, '78, p. 224).
  - New Brunswick (H. D. Rogers, '40, p. 128. Russell, '78).
  - New Durham (Darton, '83).
  - New Germantown (H. D. Rogers, '36, p. 148. H. D. Rogers, '40, pp. 132, 137, 139–140).
  - New Vernon (H. D. Rogers, '40, p. 133).
  - Orange (Cook, '81, p. 51).
  - Paterson (Cook, '81, p. 51. H. D. Rogers, '40, p. 130).
  - Palisades (Darton, '90, pp. 39–41. H. D. Rogers, '36, p. 160).
  - Plainfield (Cook, '68, p. 677).
  - Pluckemin (H. D. Rogers, '40, p. 128).
  - Pompton (H. D. Rogers, '40, p. 136).
  - Prallsville (Cook, '81, p. 59).
  - Raritan (Cook, '83, p. 26).
  - Rocky hill (H. D. Rogers, '40, p. 150).
  - Roundvalley mountain (H. D. Rogers, '40, p. 132).
  - Scotch plains (H. D. Rogers, '40, p. 134).
  - Snake hill (Russell, '88, p. 34).
  - Sourland mountain (Cook, '68, p. 191).
  - Spring hill (H. D. Rogers, '40, p. 140).
  - Stockton (Cook, '81, p. 59).
  - Trenton (H. D. Rogers, '40, p. 120).
  - Vienna (Cook, '81, p. 53).
  - Washington valley (Cook, '81, p. 53).
  - Weehawken (Gratacap, '86, pp. 244–245).
  - West Bloomfield (H. D. Rogers, '40, p. 130).
  - Woodsville (Shaler, '84, p. 144).
  - Origin of (Cook, '79, p. 33. J. D. Dana, '79. W. M. Davis, '82. W. M. Davis, '82*a*. H. D. Rogers, '40, pp. 166–171. Russell, '78, p. 229. Wurtz, '70, p. 102).
  - Table of (Cook, '68, p. 195–199. Cook, '79, pp. 29, 30. Cook, '82, pp. 22–36).
- **Dip in New York** (Darton, '90).
  - Grassy point (Mather, '39, p. 116. Mather, '43, p. 285).
  - Palisade trap sheet (Darton, '90, pp. 39–41).
  - Rockland Co. (Mather, '43, pp. 616–617).
  - Staten island (Britton, '81, pp. 168–169).
- **Dip in North Carolina** (Kerr, '75, pp. 141, 142, 145. W. B. Rogers, '42. Russell, '78, pp. 225, 253).
  - Dan river area (Emmons, '52, pp. 145–150, 151. Emmons, '56, p. 255. Macfarlane, '77, p. 527. Olmsted, '27, p. 127).
  - Deep river area (Emmons, '52, p. 120. Emmons, '56, p. 231. Emmons, '57, p. 22. W. R. Johnson, '50, p. 162. W. R. Johnson, '51, pp. 6–7. Macfarlane, '77, p. 518).
  - Farmville (Chance, '84, p. 518).
  - Germanton (McLenahan, '52, p. 170)
- **Dip in North Carolina**—Continued.
  - Haywood (McLenahan, '52, p. 168. Kerr, '75, p. 225).
  - Leaksville (Emmons, '56, p. 257. McGehee, '83, p. 77).
  - Madison (Emmons, '52, p. 151).
  - Montgomery Co. (McLenahan, '52, p. 171).
  - Walnut grove (Williams, '85, p. 59).
- **Dip in Nova Scotia.** Bay of Fundy (Russell, '78, p. 221).
  - Blomidon (Dawson, '47, pp. 50, 55, 56. Dawson, '78, pp. 90, 91. Gesner, '36, p. 222. Jackson and Alger, '33, p. 256. Marsten, '90)
  - Cape D'Or (Gesner, '36, p. 233).
  - Debert river (Ells, '85, p. 43*e*).
  - Digby (Dawson, '78, p. 95).
  - Economy point (Dawson, '78, p. 101).
  - Folly river (Dawson, '78, p. 100).
  - Horton (Dawson, '47, p. 50).
  - Kentville, (Dawson, '47, p. 56).
  - Moore river (Dawson, '78, p. 103).
  - Oak island (Dawson, '78, p. 92).
  - Outer Sandy cove (Jackson and Alger, '33, pp. 229–231).
  - Patridge island (Dawson, '47, p. 54).
  - Swan creek (Dawson, '78, p. 104)..
  - Saint Mary's bay (Alger, '27, p. 228).
  - Truro (Dawson, '47, p. 51. Dawson, '78, pp. 88, 89).
- **Dip in Pennsylvania** (Frazer, '77*c*, p. 654. Frazer, '82, pp. 122, 124–127. Frazer, '83, p. 219. Lesley, '64, pp. 478–480. Lesley, '83, pp. 180, 181, 182. Lewis, '82. Lewis, '85, p. 451. Macfarlane, '79, p. 41. H. D. Rogers, '58, vol. 2, pp. 670, 674. Shaler, '84, p. 156).
  - Abbottstown (Frazer, '76, p. 101).
  - Adams county (Frazer, '77, pp. 265–273, pl. op. p. 264. H. D. Rogers, '58, vol. 2, p. 691).
  - Bainbridge (Frazer, '86, p. 104).
  - Beeler's crossroads (Frazer, '76, p. 92).
  - Berks county (d'Invilliers, '83, pp. 200, 201, 204–226).
  - Bonnaughton (Frazer, '77*b*, Frazer, '80, p. 300).
  - Bucks county (C. E. Hall, '81, p. 49. Lesley, '85, p. xxviii).
  - Cashtown (Frazer, '77, p. 303).
  - Center valley (C. E. Hall, '83, pp. 232, 233).
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  - Cornwall inn mine (Lesley and d'Invilliers' '85).
  - Dillsburg (Frazer, '76*d*. Frazer, '77, pp. 212, 225, 236, 239, 317–331. d'Invilliers, '86, p. 1503).
  - Emigsville (Frazer, '76, p. 88).
  - Emmettsburg (Frazer, '77, pp. 254, 255).
  - Fairfield (Frazer, '80, pp. 301–304. Frazer, '82, p. 132. H. D. Rogers, '58, vol. 2, pp. 684, 691).
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  - Franklinton (Frazer, '77, pp. 271–273, pl. op. p. 272).
  - Gettysburg (Frazer, '77, pp. 254, 255, 263, 264, 299–304, pl. op. p. 304. Frazer, '77*b*. Frazer, '82, pp. 131–132).

Dip in Pennsylvania—Continued.

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Heige's ore bank (Frazer, '77, p. 224).

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Lichti's ore bank (Frazer, '77, p. 229).

Littestown (Frazer, '76, p. 108. Frazer, '77, pp. 299–304, pl. op. p. 304).

M'Cormick mine (Frazer, '77, p. 215).

March's mill (d'Invilliers, '83, p. 202).

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Monroe (C. E. Hall, '83, p. 247. H. D. Rogers, '58, vol. 2, p. 681).

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York county (Frazer, '75*c*).

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Dan river area (W. B. Rogers, '39, p. 80).

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Columnar trap at (Cook, '68, p. 203).

Dip at (Cook, '68, p. 198).

Dip in shale at (Cook, '82, p. 25).

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Fossil fern from, description of (E. Hitchcock, jr., '55).

Fossil fern from, mention of (Fontaine, '83, p. 57. E. Hitchcock, 55*a*, p. 408).

Fossil plants found at, mention of (Newberry, '88, p. 12).

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Structure of (Percival, '42, p. 314).

Trap ridge near (Percival, '42, pp. 326–330).

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In Am. Jour. Sci., vol. 30, pp. 330–354.
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Deep river coal field.	Page.
Masses composing the formation	227-239
Considerations respecting age	227-239
Geographical extent of coal measures, together with the under and over lying sandstones	239-246
Quantity and quality of the Deep river coal, composition, etc	246-254
The Dan river coal field. Description of (E. Emmons)	259-291
Economic products of the coal fields and of the red sandstones	261-268
The advantages of Deep river for the manufacture of iron, etc	268-270
History of opinions respecting the age of the Deep and Dan rivers formations. Division of the series with remarks sustaining it	271-283
Description of organic remains	283-338
The coal fields of Deep river and of Richmond, Va., compared	338-342

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CONTENTS.

	Page.
Preface	v-vii
Subject stated in the preliminary remarks	1
Geographical distribution of the Permian and Triassic (Newark) systems of the Atlantic slope	2-4
Of the relations which exist among the sandstones and slates of the different troughs or basins which have been described	5-13
Comparisons of the beds described in the foregoing sections and their subdivisions proposed	13-16
Proposed divisions and comparisons with European equivalents	16-18
General statements respecting the series of rocks to be described. Conglomerate, its composition and variable thickness. Brown and red sandstone, its parallelism with Rothe Todte Liegendes, its fossils	19-20
Lithological character of the coal measures of Rothe Todte Liegendes, composition of the coal shales, black band, etc. Beds penetrated by the Egypt shaft; Dan river coal seams	29-34
Fossils of the coal slates and shales, sandstones, etc	34-36
Of the animal remains of the slates and shales of the Chatham series	36-54
Reptilia; characteristics of reptiles and their general distribution in the rocks	54-57
The saurian remains of the Chatham series	58-65
Mammal of the Permian epoch	93-96
Subject-matter respecting the upper or the Triassic (Newark) series	97-98
Fossils of the Newark system referred to their proper classes and orders	99-134
Footprints or body imprints found in the upper series or Trias	135-141
Vertebrata	142-149
On the pyroplastic rocks belonging to the sandstone series	149-151

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Enfield falls, Mass. Brief account of sandstone near (E. Hitchcock, '35, p. 221).

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Indurated shale near (Darton, '90, p. 52).

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Outcrops of trap and sandstone near (Cook, '68, p. 178).

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In Am. Jour. Sci., 3d ser., vol. 31, p. 72.

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EYERMAN, JOHN. **1889.**

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In notes on geology and mineralogy. In Philadelphia Acad. Nat. Sci. Proc., 1889, [vol. 40], pp. 32–33.

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Contact metamorphism near (H. D. Rogers, '58, vol. 2, p. 684, 691).

Copper ore at, detailed account of (Frazer, '80, p. 301–304).

Copper ores near (Frazer, '82, pp. 132–134).

Dip at (Frazer, '80, p. 301).

Dip in shale near (H. D. Rogers, '58, vol. 2, pp. 684–691).

Iron ore near (H. D. Rogers, '58, vol. 2, p. 691).

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Fairfield, S. C. Description of trap dikes in (Tuomey, '44, p. 12).

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Trap dike in, mention of (Hovey, '89, p. 377).

Trap dike near (W. M. Davis, '83, p. 268).

Trap ridges near, description of (Percival, '42, pp. 331, 333, 335).

Trap rocks near, description of (Davis and Whittle, '89, pp. 110–111).

Fair Haven, East, Conn. Contact metamorphism near (Hovey, '89, pp. 369–375).

Trap ridges near (Hovey, '89, p. 366).

Fairmont Hill, N. J. Structure of (Darton, '90, p. 43).

Fair View, Pa. Mention of a trap dike near (Frazer, '84, p. 693).

Fairville, N. J. Dip in sandstone at (Cook, '82, p. 24).

Fairville, Pa. Boundary of the Newark near (Frazer, '80, p. 15, 48, 49).

Fall mountain, Mass. Description of scenery near (E. Hitchcock, '23, vol. 7, p. 12).

Fall river, Mass. Description of faults at the mouth of (Emerson, '82, pp. 195–196).

Falls of the Passaic, N. J. Contact metamorphism near (H. D. Rogers, '40, p. 146).

Description of trap outcrop at (H. D. Rogers, '40, p. 146).

Falmouth, Pa. Detailed description of the Newark rocks near (Frazer, '80, pp. 103–104).

Falmouth, Pa.—Continued.

Trap near, description of (Frazer, '80, p. 34. H. D. Rogers, '58, vol. 2, p. 687).

Fanwood, N. J. Description of the geology near (W. M. Davis, '83, p. 275).

Farmersville, N. C. Analysis of blackband from (Emmons, '56, p. 264).

Analysis of coal from (Emmons, '56, pp. 247–248, 249, 250. Kerr, '75, pp. 293–294).

Boundary of the Newark near (Emmons, '56, p. 244).

Brief account of coal at (Emmons, '57*a*, p. 7).

Dips and strikes near (W. R. Johnson, '51, pp. 6–7).

Fossil reptilian bones from (Emmons, '57, p. 92).

Outcrop of coal in (Wilkes, '58, p. 4).

Thickness of coal seams near (W. R. Johnson, '51, p. 8).

Unconformity of Newark and Taconic near (Emmons, '56, p. 242).

Farmington, Conn. Building stone from, brief account of (E. Hitchcock, '35, p. 46).

Building stone near (Percival, '42, p. 439).

Indurated bitumen found near (Percival, '42, pp. 375, 376).

Limestone near (Percival, '42, pp. 316, 443).

Overflow trap sheets near (W. M. Davis, '88, p. 464).

Sandstone quarries near (Shaler, '84, p. 127).

Trap ridges near (Percival, '42, pp. 368–370).

Farmington hills, Conn. Analysis of diabatite from (Hawes, 75*a*).

Topographic form of trap ridge near (Percival, '42, p. 304).

Farmington mountain, Conn. Anterior trap ridge of (Davis and Whittle, '89, pp. 109–110).

Description of (Percival, '42, p. 374).

Small map of (Davis and Whittle, '89, pl. 3).

Farmington river gap, Conn. Trap ridges near (Davis and Whittle, '89, p. 109).

Farmville, N. C. Analysis of coal and natural coke from (Battle, '86).

Analysis of coal from (Chance, '84).

Coal at (Macfarlane, '77, p. 519).

Coal at, quality of (Emmons, '52, p. 131).

Coal near, explorations for (Chance, '85, pp. 26–33).

Dip at (Macfarlane, '77, p. 518).

Dip of coal seams near (Chance, '84, p. 518).

Reference to fossil fishes from (E. Hitchcock, '41, p. 440).

Reptile remains from (Emmons, '56, p. 309).

Section of coal seams at (Chance, '85, p. 22).

Section of coal seams near (Emmons, '52, pp. 124–129).

Sketch showing outcrop of coal near (Chance, '85, p. 27).

Farmville, Va. Boundary of the Newark near (W. B. Rogers, '39, pp. 74–76).

Mention of coal shales and coal seams at (Heinrich, '78, p. 272).

Short account of coalfield near (Daddow and Bannan, '66, pp. 402–403).

Farmville area, Va. Brief account of (Emmons, '57, p. 3. Hotchkiss, '81, p. 120).

Farmville area, Va.—Continued.
Brief review of the occurrence of coal in (Chance, '85, pp. 18–19).
General account of the coal of (Patton, '88, p. 23).

Faults. Brief discussion of (W. M. Davis, '88, pp. 469–481).

Faults in Connecticut. Discussion of (Hovey, '89, pp. 378–379. W. M. Davis, '89*c*).
Detailed study of, near Meriden (W. M. Davis, '89).
Map of, near Meriden (W. M. Davis, '89*c*, p. 424).
Possible existence of (E. Hitchcock, '58, p. 15).
South Britain (W. M. Davis, '88, p. 472).
Woodbury, section showing (W. M. Davis, '88, p. 472).
See, also, Connecticut valley.

Faults in Connecticut valley. (W. M. Davis, '82. W. M. Davis, '82*a*, pp. 120–124. W. M. Davis, '83. W. M. Davis, '88. W. M. Davis, '91. Davis and Loper, '91. Davis and Whittle, '89. Percival, '42, p. 300).
Discussion of (W. M. Davis, '86, p. 344. W. M. Davis, '88. W. M. Davis, '89*b*, pp. 27–29).
Hypothetical section of (W. M. Davis, '86, p. 350).
Marginal (W. M. Davis, '88, p. 474).
Origin of (W. M. Davis, '88*a*).
Systematic arrangement of (W. M. Davis, '88, pp. 474–477).
See, also, Connecticut and Massachusetts.

Faults in Massachusetts. At mouth of Fall river (Emerson, '82).
See, also, Connecticut valley.

Faults in New Jersey. (Cook, '79, p. 33. Cook, '82, p. 16. Cook, 83, p. 25. Cook, '87. Cook, '89, pp. 13–14. Darton, '90. W. M. Davis, '82. W. M. Davis, '83. Lesley '83, p. 181. Nason, '89, pp. 25, 32–33).
At Belleville (Cook, '81, p. 44).
Garret rock (Darton, '90, p. 23).
Haledon quarry (Cook, '83, p. 25, pl.).
Hudson county (Darton, '90. Russell, '80, pp. 32–33).
Lambertville (Lesley, '83, p. 181).
Palisades (Nason, '89, p. 26).
Paterson (W. M. Davis, '83, p. 309, pl. 11).
Plainfield (Cook, '68, p. 677).
General, absence of (Cook, '68, p. 202).

Faults in New York. In Palisade trap sheet (Darton, '90, pp. 41–45).

Faults in North Carolina. Deep river area (Chance, '85, p. 59).
Gulf (Emmons, '56, p. 241).

Faults in Nova Scotia. (Dawson, '78, p. 104).

Faults in Pennsylvania. (Frazer, '84. Lewis, '85, p. 440. H. D. Rogers, '58, vol. 1, pp. 86, 87).
Border of the Newark (Lesley, '63, pp. 188–189).
Bucks county (Lesley, '85, p. xxvii).
Cornwall iron mine (Lesley and d'Invilliers, '85, pp. 496–506).
Dillsburg (Frazer, '77, pp. 328–330. d'Invilliers, '86, p. 1508).
Yardleyville (Lewis, '82).

Faults in Pennsylvania—Continued.
Yellow springs (H. D. Rogers, '58, vol. 1, p. 88).

Faults in Virginia. Farmville (Daddow and Bannan, '66, p. 403).
Midlothian (Fontaine, '79, p. 36).
Richmond area (Fontaine, '79, pp. 35, 36. Newell, '89. W. B. Rogers, '36, pp. 55–56. Shaler, '71, pp. 114, 118).
Origin of, briefly considered (W. M. Davis, '89*a*, p. 196).
Producing overlap, diagrams showing (W. M. Davis, '88, p. 475).
Various observations cited (W. M. Davis, '83, pp. 304–305).

Fauquier county, Va. Character of conglomerate in (W. B. Rogers, '39, p. 72).
Description of the Newark in (W. B. Rogers, '40, pp. 64–69).
Reference to fossil fishes from (E. Hitchcock, '41, p. 440).

Fayettesville, Va. Boundary of Newark near (Heinrich, '78, p. 235).

Feltville, N. J. Absence of contact metamorphism at (Darton, '89, p. 135).
Baryta at (Cook, '68, p. 709).
Boundary of First mountain, trap at (Cook, '68, p. 182).
Boundary of Second mountain, trap at (Cook, '68, p. 183).
Copper ores near (Cook, '68, p. 676).
Description of the geology near (W. M. Davis, '83, pp. 274–276).
Dip at (Cook, '68, p. 196).
Dip in sandstone at (Cook, '82, p. 24).
Junction of trap and sandstone at (Russell, '78*a*).
Limestone at (Cook, '68, p. 214. Cook, '79, p. 18. Cook, '82, pp. 22, 42).
Limestone near (Nason, '89, p. 22).
Sandstone above trap at (Cook, '68, p. 201).
Section of trap sheet near (Darton, '90, p. 26).
Surface of trap sheet at (Darton, '90, p. 26).
Trap exposures near (W. M. Davis, '83, p. 309, pl. 11).

Ferrish's coal mine, N. C. Analysis of coal from (W. R. Johnson, '50, p. 165. Macfarlane, '77, p. 525).
Discovery of (W. R. Johnson, '50, pp. 161–162).

Fiddlers creek, N. J. Dip near (Cook, '68, pp. 197, 198).

FIELD, ROSWELL. 1855.
[On fossil footprints from Greenfield, Connecticut.]
In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 160, 166).
Describes a slab of sandstone covered with footprints.

FIELD, ROSWELL. 1856.
[Note on the discovery of the footprint of a biped web-footed animal at Greenfield, Massachusetts.]
In Boston Soc. Nat. Hist., Proc., vol. 6, pp. 10, 11.
A brief extract from a letter relating to the discovery.

FIELD, ROSWELL. 1860.

Orinthichnites, or tracks resembling those of birds.

In Am. Jour. Sci., 2d ser., vol. 29, pp. 361–363.

Abstract in Neues Jahrbuch, 1861, pp. 877, 878.

Discusses the ornithic character of the footprints discovered in the Connecticut valley; shows that some of the three-toed tracks were made by four-footed animals.

FIELD, ROSWELL. 1860a.

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In Boston Soc. Nat. Hist., Proc., vol. 7, pp. 316–317.

Discovery of fossil at Turners Falls, Mass. (E. Hitchcock, '58, p. 7).

Field copper mine, N. J. Altered shale near (Cook, '83, p. 24).

Contact of trap and sandstone at (Cook, '82, p. 51).

Dip in shale at (Cook, '82, p. 24).

Fossil Estherias and fishes found in (Nason, '89, pp. 29, 30).

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Filler's ore pit, Pa. Report on (Frazer, '77, p. 222).

FINCH, J. 1826.

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In Am. Jour. Sci., vol. 10, pp. 209–212.

Contains some observations on the Newark sandstone in New Jersey, dissents from the use of the name Old Red sandstone for that terrane, and uses the name New or Variegated sandstone instead.

FINCH, JOHN. 1828.

On the geology and mineralogy of the country near Westchester, Pa.

In Am. Jour. Sci., vol. 14, pp. 15–18.

Brief account of the Newark sandstone (called second or variegated sandstone) and associated trap near Westchester, Pa.

FINCH, J. Cited on the age of the Newark system (C. H. Hitchcock, '71, p. 21).

Fire clay in North Carolina. (Chance, '85, p. 25. Emmons, '56, pp. 265-266. Kerr, '66, pp. 46, 47).

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First Newark mountain, N. J. Boundaries of (Cook, '68, pp. 180–182).

Brief description of (Russell, '78, p. 241).

Building stone near (Cook, '68, p. 506).

Contact metamorphism near (Cook, '87, p. 125).

Copper ores of the (Cook, '68, p. 676).

Description of (Cook, '68, pp. 179–182. Cook, '82, pp. 49–52).

Detailed description of (Darton, '90, pp. 19–32).

Dip in (Cook, '68, p. 195).

Dips in the associated sandstone (Walling, '78, p. 196).

Gaps in (Cook, '82, p. 50).

Lower contacts of trap sheet of (Darton, '90, pp. 25–31).

First Newark mountain, N. J.—Continued.

Origin of (Russell, '78*a*).

Origin of, discussed (Wurtz, '70, p. 10).

Overflow origin of (W. M. Davis, '82).

Probable faults near (Nason, '89, p. 26).

Sketch of faulted trap near Paterson (W. M. Davis, '83, p. 300, pl. 11).

Solid hydrocarbon in (Russell, '78*b*).

See, also, Watchung mountains.

Fishers mills, S. C. Description of trap dikes near (Tuomey, 44, p. 11).

Fishes, fossil. (Emmons, '57, pp. 142–145, pls. 9, 9*a*. H. D. Rogers, '58, vol. 2, pp. 695, 760–761, 764.)

Age indicated by (Newberry, '88, pp. 11–12).

Description and figures of (Newberry, '88).

General account of (Lyell, '66, p. 456).

Geological position of (Newberry, '85).

Observations on (Lea, '53, p. 193).

Position in scheme of classification (E. Hitchcock, '58, p. 147).

Progress in study of (W. C. Redfield, '55*a*).

Remarks on (E. Hitchcock, '58, p. 144).

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Summary concerning (Miller, '79–'81, vol. 2, p. 243).

Fishes, fossil, from Connecticut. Discussion concerning (Brongniart and Silliman, '22).

Little falls, (C. H. S. Davis, '87, p. 21).

Mention of (Percival, '42, pp. 442, 444, 446, 447, 451).

Middlefield (Anonymous, '38).

Southbury (E. Hitchcock, '28, p. 228).

Westfield (Anonymous, '38. Silliman, '21, pp. 221, 222).

Fishes, fossil, from Connecticut valley. (Davis and Loper, '91. De Kay, '42. Warren, '54, p. 42).

Brief account of (E. Hitchcock, '23, vol. 6, pp. 76–79, pl. 9. E. Hitchcock, '37, p. 267. E. Hitchcock, '56. E. Hitchcock, '58).

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Localities of (Mather, '34).

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Position of in reference to trap sheets (E. Hitchcock, '55, p. 226).

Reference to (E. Hitchcock, '41, pp. 437, 438).

Sunderland (Anonymous, '54. Silliman, '21*a*).

Turners Falls (E. Hitchcock, '58, pp. 145, 146).

Fishes, fossil, from New Jersey. Boonton (Anonymous, '54).

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Field's copper mine (Cook, '82, p. 51).

List of (De Kay, '42).

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Fishes, fossil, from New Jersey—Continued.
Mention of (Cook, '68, p. 174).
Morris county (W. C. Redfield, '39).
Pompton (W. C. Redfield, '43).
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Phœnixville (Cope, '85. Lesley, '83, p. 213, Wheatley, '61, p. 44).
Yerkis station (Leidy, '76).

Fishes, fossil, from Virginia. Brief account of (Lyell, '47, pp. 275–278. Lyell, '49, p. 282. W. B. Rogers, '43, p. 300).
List of (Heinrich, '78, p. 264).
Mention of (W. B. Rogers, '43, p. 315. Wooldridge, '42).
Note on (W. C. Redfield, '38*a*).
Reference to (E. Hitchcock, '41, p. 440).

Fiskdale, Conn. Description of trap dikes in primary rocks at (Percival, '42, pp. 419, 420).

Five islands, N. S. Brief account of Newark rocks on (Honeyman, '78).
Copper ores at (How, 69, p. 72).
Description of (Dawson, '78, p. 101. Gesner, '36, pp. 259–262. Jackson and Alger, '33, p. 272).
Mention of (Marsters, '90).
Rocks near (Dawson, '78, pp. 102–104. Gesner, '36, p. 170).
Sandstone beneath trap at (Dawson, '47, p. 52).
Trap dikes near (Ells, '85, p. 7E).

Fivemile Fork, N. J. Abandoned quarries near (Cook, '81, p. 55).

Fivemile house, Pa. Exposure of trap and sandstone near (d'Invilliers, '83, p. 225).

Fivemile lock, N. J. Dip in shale at (Cook, '79, p. 30).
Dip near (Cook, '68, p. 196).
Sandstone quarry near (Cook, '79, p. 23).

Flagstone in Maryland. Brief account of (Tyson, '60, appendix, pp. 5–6).

Flagstone in New Jersey. (Cook, '68, p. 521. Cook, '81, pp. 63–64).
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Flagstone quarries in New Jersey. (Cook, '79, pp. 20, 25).

Flagtown, N. J. Description of Sourland mountain near (Cook, '68, pp. 191–192).
Description of trap, contact metamorphism, etc., near (H. D. Rogers, '40, pp. 152–153).
Dip near (Cook, '68, pp. 198–199).
Synclinal axis near (H. D. Rogers, '40, p. 128).
Termination of trap ridge at (Cook, '82, p. 61).

Flagtown, Pa. Trap near (C. E. Hall, '81, p. 80).

Flemington, N. J. Analysis of trap from (Cook, '68, p. 216).
Arenaceous strata near (H. D. Rogers, '40, pp. 123–124).

Flemington, N. J.—Continued.
Copper ores at (H. D. Rogers, '40, pp. 159, 160–163).
Description of copper mines at (H. D. Rogers, '36, pp. 169–170).
Description of sandstone outcrops near (H. D. Rogers, '36, p. 153).
Description of trap outcrops near (Darton, '90, p. 67).
Dip at (Cook, '68, p. 197).
Dip in indurated shale near (Cook, '82, p. 27).
Dip in sand rock near (Cook, '82, p. 27).
Dips near, diverse (Nason, '89, pp. 18, 19).
Evidence of faulting near (Nason, '89, p. 33).
Fossil crustaceans found near (Nason, '89, p. 30).
Map showing trap outcrops near (Darton, '90, p. 66).
Origin of trap rock near (Darton, '89, p. 138).
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Report on copper mine near (Dickeson, '59. E. and C. H. Hitchcock, '59).
Trap hill near (Nason, '89, p. 36).
Trap intrusion near (H. D. Rogers, '36, p. 154).
Trap outcrops near (Darton, '90, p. 70).
Trap rock of (Cook, '82, pp. 62–63).

Flemington copper mine, N. J. (Cook, '68, p. 679).
Brief account of (H. D. Rogers, '36, p. 167).
Description of (H. D. Rogers, '40, pp. 162–163).
Trap dike at (Cook, '68, p. 204).

Floraville, N. J. Boundary of trap outcrop near (Cook, '68, p. 177).
Indurated shale near (Darton, '90, p. 52).

Flourtown, Pa. Brief account of trap dike near (C. E. Hall, '81, p. 75. H. D. Rogers, '58, vol. 1, p. 214).
Description of trap dikes near (C. E. Hall, '81, pp. 19–20).
Map showing continuation of trap dike near (C. E. Hall, '81, p. 23).
Reference to a trap dike near (Lewis, '85, pp. 439–441).
Trap dikes near (C. E. Hall, '81, pp. 19–20, 75).

Fluvanna county, Va. Boundary of the Newark in (W. B. Rogers, '39, p. 74).

Flying hill, Pa. Trap and conglomerate at (d'Invilliers, '83, pp. 203, 204, 221–223).

Flying hill run. Description of trap dikes near (H. D. Rogers, '58, vol. 2, p. 686).

Folly river, N. S. Contact of Newark and Lower Carboniferous near (Ells, '85, p. 48E).
Description of Newark rocks near (Ells, '85, p. 7E).
Dip at (Dawson, '78, p. 100).
Rocks at (Dawson, '78, p. 100).
Section at (Dawson, '47, p. 51, pl. 5).

Folly river bridge, N. S. Exposure of Newark rocks near (Honeyman, '74, pp. 345–346).

FONTAINE, WILLIAM M. 1879.
Notes on the Mesozoic strata of Virginia.
In Am. Jour. Sci., 3d ser., vol. 17, pp. 25–39, 151–157, 229–239.

FONTAINE, WILLIAM M.—Continued.

Reviewed by P. Frazer in Am. Nat., vol. 13, pp. 284–292.

Abstract in Neues Jahrbuch, 1881, pp. 137–138.

Classifies and describes the various Newark areas in Virginia, discusses the character and relations of their fossil plants, and presents theoretical considerations in reference to the causes which exterminate the "Jurassic" flora. The age of the two principal divisions of the Mesozoic of Virginia also receives attention.

FONTAINE, WILLIAM MORRIS. 1883.

Contributions to the knowledge of the Older Mesozoic flora of Virginia.

Washington (Interior Dep., U. S. Geological Survey, Monograph No. 6, pp. i–xi, 1–144, pls. 1–54).

Reviewed by D. Stur in Verhandlungen der k. k. geologischen Reichsanstalt, No. 10, 1883, and by J. Marcou in Am. Geol., vol. 5, pp. 160–174; see also The Virginias, vol. 6, pp. 38–40.

Abstract in Am. Jour. Sci., 3d ser., vol. 30, p. 162.

Contains a sketch of the geology of the Newark system, pp. 1–9. Describes and figures fossil plants collected mainly at Clover hill, Va., and consisting principally of ferns, together with a few specimens of Equisetæ; Schizoneura, fruits of cycads, and some undetermined plants, pp. 10–92. General observations on the relation of the flora to that of the Trias, Jura, and Rhetic of Europe, pp. 92–96. The Older Mesozoic flora of North Carolina, as treated in E. Emmons' "American Geology, Part VI," is also presented, pp. 57–121, followed by general remarks and conclusions, pp. 121–128. Explanation of plates, pp. 129–140.

FONTAINE, WILLIAM MORRIS. 1889.

The Potomac or younger Mesozoic flora.

U. S. Geol. Surv., Monog. No. 15, in two parts.

Refers to the unconformity of the Potomac with the Newark rocks beneath, in Virginia, part 1, pp. 58–59.

FONTAINE, W. M. Abstract of notes on the geology of Virginia. See Frazer, '82, p. 140.

Cited on age of the Newark system (Newberry, '88, p. 10).

Cited on fossil flora (Dawson, '88, pp. 176, 246. Marcou, '88, p. 33. Newberry, '88. Zeiller, '88).

Review of report on older Mesozoic flora by (Marcou, '90).

Review of work by (Stur, '88).

Fooshee, N. C. Exploration for coal near (Chance, '85, pp. 49–50).

Footprints, fossil. Brief sketch of (H. D. Rogers, '58, vol. 2, pp. 760–761).

Characteristics and paleontological value (E. Hitchcock, '60).

Classification of (E. Hitchcock, '36, pp. 315–317).

Footprints, fossil—Continued.

Classification of, with list of species (E. Hitchcock, '44*a*, pp. 316–318).

Comparative study of (E. Hitchcock, '58, pp. 24–45).

Compared with footprints of living animals (E. Hitchcock, '41, pp. 504–508, pls. 49, 50, 51).

Comparison of, with recent footprints (Desor, '49).

Credit given E. Hitchcock for the investigation of (H. D. Rogers, '44, pp. 249–250).

Description and illustrations (E. Hitchcock, '65).

Description of species (C. H. Hitchcock, '88, pp. 123–127. E. Hitchcock, '36, pp. 317–329. E. Hitchcock, '42).

Descriptive catalogue of, in the Hitchcock cabinet at Amherst college (C. H. Hitchcock, '65).

Discussion concerning (Murchison, '43).

Discussion of the nature of (E. Hitchcock, '36, pp. 313–316).

Discussion of the principles of classification (E. Hitchcock, '48).

Doubtful species of (E. Hitchcock, '65, p. 2).

Early observations on (Barratt, '45).

Evidence of having been made on a sloping surface (W. B. Rogers, '42*a*).

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Illustrations of (Bouvé).

Inferences from (Cook, '68, p. 338).

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Physical conditions shown by (J. D. Dana, '75, p. 420).

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Remarks on the classification of (Cope, '69, p. 242).

Revised list of (C. H. Hitchcock, '71. C. H. Hitchcock, '88).

Sketch of progress in the study of (Warren, '55).

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Statements in reference to the nature of (J. D. Dana, '65).

Table showing classification of (E. Hitchcock, '48, pp. 165–168).

Footprints, fossil, from Connecticut. Additional localities (E. Hitchcock, '37*b*).

Greenfield, description of (Field, '55).

Middletown, mention of (Anonymous, '38*a*. Barratt, '37).

Reference to (Adams, '46*a*. Silliman, '37).

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Footprints, fossil, from the Connecticut valley—Continued.

- Brief account of (Adams, '46, pp. 101-102. Deane, '42. E. Hitchcock, '37, pp. 271-273. E. Hitchcock, '55*a*, pp. 181-189. E. Hitchcock, '56. E. Hitchcock, '58, p. 173. Le Conte, '84, p. 327. Lyell, '66, pp. 453-456. Lyell, '45, vol. 1, pp. 252-255. Lyell, '71, p. 361. Mantell, '43. Murchison, '43*a*. Macfarlane, '79, p. 63. Owen, '43. Owen, '59, pp. 181, 182, 324-327. Pictet, '53. Shaler, '85, pp. 218-219. Steel, '74, pp. 184-185).
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- Conclusions from study of (E. Hitchcock, '58, pp. 172-175.
- Crustaceans (Dana, '58*a*. Leidy, '58).
- Description and figures of (Deane, '49).
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- Description of (Deane, '45*d*. E. Hitchcock, '56*a*. E. Hitchcock, '58).
- Discussion as to the nature of the animals that made them (Field, '60).
- Discussion of the conditions under which they were formed (E. Hitchcock, '47, pp. 56-57).
- First discovery of (Mackie, '64).
- General account of (Emmons, '46, p. 201. Deane, '43).
- Illustrations of (Gray and Adams, '60, pp. 247-252).
- Insects (Warren, '55).
- List of (E. Hitchcock, '37*a*).
- Localities of (E. Hitchcock, '48, pp. 131-132. E. Hitchcock, '58, pp. 45-50. D. Marsh, '48).
- Marsh cited on the reptilian character of (Hull, '87, p. 86).
- New facts concerning (E. Hitchcock, '63).
- Notice of discoveries of (W. C. Redfield, '38).
- Popular account of (E. Hitchcock, '58, pp. 175-190. Russell, 77. Winchell, '70. pp. 180-187).
- Position of, in the strata (E. Hitchcock, '58, p. 20).
- Priority of discovery of (Bouvé, '59. Deane, '44*a*. Deane, '44*b*. E. Hitchcock, '44*d*. E. Hitchcock, '58, pp. 191-199. W. B. Rogers, '59).
- Probable reptilian or mammalian character of, brief remarks on the (Field, '60).
- Reasons for doubting that they were made by birds (L. Agassiz, '55).
- Remarks on (H. D. Rogers, '58, vol. 2, p. 694).
- Review of the controversy concerning the discovery of (E. Hitchcock, '44*a*).
- Revised classification of (Cope, '69, p. 242. E. Hitchcock, '45).
- Synopsis of (E. Hitchcock, '58, p. 174).
- Table showing characteristics of (E. Hitchcock, '58, pp. 201-205).
- Table showing measurements of (E. Hitchcock, '48, pp. 181, 191, 196, 211, pl. op. p. 256).
- Thickness of rocks containing (H. D. Rogers, '56, p. 32).
- Upheaval of sandstone strata since the origin of (E. Hitchcock, '55, p. 226).

Footprints, fossil, from Massachusetts. Conditions under which they were made (E. Hitchcock, '41, pp. 512-513).

- Description of (E. Hitchcock, '47. E. Hitchcock' '58. Warren, '55, pp. 305-306).
- Description of five new species from near Turners Falls (E. Hitchcock, '43*a*, p. 254).
- Detailed account of (E. Hitchcock, '41, pp. 464-525, pls. 30-51).
- Doubtful origin of (E. Hitchcock, '41, p. 501).
- General account of, with description and figures of species (E. Hitchcock, '36).
- General description of a small slab of (Mantell, '46).
- General description of the nature and situation of (E. Hitchcock, '41, pp. 467-474, pls. 30-49).
- Greenfield (Field, '56).
- In state cabinet (E. Hitchcock, '59).
- Localities of (E. Hitchcock, '41, pp. 465-467).
- Manner in which they succeed each other (E. Hitchcock, '41, pp. 517-518, pl. 47-51).
- Mention of (Packard, '71).
- Position of, in reference to trap sheets (E. Hitchcock, '55, p. 226).
- Quadruped from Turners Falls (Deane, '48).
- Remarks upon (E. Hitchcock, '45*c*).
- Showing a succession of tracks (E. Hitchcock '41, pp. 500-501, pls. 47, 48, 49).
- Specific description of (E. Hitchcock, '41 pp. 474-501).
- Summary of species of (E. Hitchcock, '41, p. 499).
- Turners Falls description of (Deane, '45. Deane, '47. Deane, '50. Deane, '56. C. H. Hitchcock, '66).

Footprints, fossil, from New Jersey. (Cook, '79, p. 28).

- Boonton (Russell, '79).
- Brief reference to (W. C. Redfield, '43*a*).
- Description of the occurrence of (W. C. Redfield, '43).
- Geological museum at Trenton (Cook, '79, p. 28).
- Location where found (Nason, '89, p. 28).
- Mention of (Emmons, '46, p. 201).
- Mention of localities of (Russell, '78, p. 225).
- Milford, brief description of (Eyerman, '86).
- List of, see Eyerman, '89.
- New Vernon, mention of (Cook, '85, p. 95).
- Popular account of (Russell, '77).
- Reference to the discovery of (E. Hitchcock, '43*a*, p. 255).
- Remark on (C. H. Hitchcock, '89).
- Weehawken (Gratacap, '86).
- Whitehall, mention of (Cook, '85, pp. 95-96).

Footprints, fossil, from New York. State cabinet (Anonymous, '54).

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- Goldsboro (Wanner, '89).
- Names given to (Lea, 56, p. 78).
- Phœnixville (Jones, '62, p. 95. Wheatley, '61, p. 45).
- Remarks on (C. H. Hitchcock, '89).

Footprints of existing reptiles for comparison with fossil footprints. (Deane, '61, p. 44, pls. 21, 22).

Forestville, Conn. Sandstone quarries near (Shaler, '84, p. 127).

Forestville, Pa. Trap dike near (Lewis, '85, p. 447).

Fort Hale, Conn. Description of trap ridges near (Percival, '42, p. 329).

Fort Hans, N. Y. Boundary of trap near (Cook, '68, p. 192).

Elevation of Sourland mountain at (Cook, '68, p. 191).

Fort Lee, N. J. Boundary of trap outcrop at (Cook, '68, p. 177).

Character of trap ridge near (Darton, '90, pp. 38, 47-48).

Contact metamorphism at (Cook, '68, p. 208).

Copper ore under trap at (Cook, '68, p. 676).

Description of geology near (W. M. Davis '83, pp. 269-271).

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Dip at (Cook, '68, p. 195).

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General account of geology near (Pierce, '20, pp. 182-184).

Section of the Palisades south of (Cozzens, '43, pl. 2).

Trap ridge near (Darton, '90, pp. 47-48).

Fort Washington, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 75. Lesley, '85, p. lxxxi).

Conglomerate at (C. E. Hall, '81, p. 24).

FOSTER [J. W.]. **1851.**

[Remarks on the geological position of the Newark system and on the structure of the Connecticut valley sandstone.]

In Am. Assoc. Adv. Sci., Proc., vol. 5, p. 46.

Abstract in Ann. Sci. Discov., 1852, p. 260.

Remarks on a paper by W. C. Redfield, in reference to the age of the rocks mentioned, as indicated by stratigraphy. Discusses also the evidence of an unconformity in the sandstones of the Connecticut valley.

FOSTER, J. W. **1869.**

The Mississippi valley, its physical geography, [etc.].

Chicago and London. pp. i-xvi, 1-443.

Contains a brief account of the Newark system, p. 306, and a geological sketch map of the United States, pl. op. p. 273.

Fountainville, Pa. Trap dikes near (Lewis, '85, p. 453).

Franklin, N. J. Bored well at (Cook, '85, pp. 117-118).

Oolite at (Eaton, '30).

Franklin copper mine, N. J. Description of (Cook, '68, p. 679. H. D. Rogers, '36, p. 168. H. D. Rogers, '40, p. 161).

Franklin county, Mass. A study of stratigraphy in (Walling, '78).

Franklin county, Pa. Geological map of (Sanders, '81).

Report on the geology of (Frazer, '77).

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Dip in sandstone at (Cook, '82, p. 30).

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Sandstone quarry at (Cook, '79, p. 22).

Trap hill near (Cook, 82, p. 49).

Franklintown, Pa. Catalogue of specimens of sandstone, etc., near (Frazer, '77, pp. 332-381).

Concerning the mines at (Frazer, '77*c*, pp. 654-655).

Isolated area of schist in Newark rocks near (Frazer, '77*c*, p. 651).

Mention of various rock specimens from near (C. E. Hall, '78, pp. 33-36).

Section from near, to Wellsville (Frazer, '77, pp. 271-273, pl. op. p. 272).

FRAZER, PERSIFOR, Jr. **1874.**

Weathering of rocks [at Gettysburg, Pa.].

In Philadelphia Acad. Nat. Sci., Proc., vol. 26, p. 228.

Brief description of the weathering of trap rock (syenite) at Gettysburg.

FRAZER, P[ERSIFOR], Jr. **1874a.**

On exfoliation of rocks near Gettysburg.

In Am. Phil. Soc., Proc., vol. 14, 1874-1875, pp. 295-297.

Describes the weathering of trap rock (syenite) near Gettysburg, Pa.

FRAZER, PERSIFOR. **1875.**

On some thin sections of the Lower Paleozoic and Mesozoic rocks of Pennsylvania.

In Am. Inst. Mining Eng., Trans., vol. 3, pp. 327-328.

Brief general statement of the results of an examination of thin sections of sandstone and trap from York and Adams counties, Pa.

FRAZER, PERSIFOR. **1875a.**

On the traps of the Mesozoic sandstone in York and Adams counties, Pa.

In Am. Philo. Soc., Proc., vol. 14, 1876, pp. 402-414, pls. 1-4.

Discusses the chemical composition and optical properties of certain trap rocks from West Rock, Conn., and from near York, Gettysburg, and Dillsburg, Pa. Presents complete analyses of trap from West Rock and from near York.

FRAZER, PERSIFOR. **1875b.**

[Comparison of microscopical section and fragments of trap from near Gettysburg, Pa., with similar samples and sections of the trap rocks of Connecticut.]

In Am. Philo. Soc., Proc., vol. 14, pp. 430-431.

Presents the results of the comparison indicated in the title.

FRAZER, PERSIFOR. **1875c.**

On the Trias of York county, Pa.

In Philadelphia Acad. Nat. Sci., Proc., vol. 27, p. 123.

Brief remarks on the dip of Newark strata and on the unconformity of Newark and Silurian rocks in York county, Pa.

FRAZER, PERSIFOR, Jr. **1875d.**

On the Mesozoic red sandstone of the Atlantic states.

FRAZER, PERSIFOR, Jr.—Continued.

In Philadelphia Acad. Nat. Sci., Proc., vol. 27, pp. 440-442.

General considerations relating to the problems presented by the Newark system.

FRAZER, PERSIFOR, Jr. 1876.

Second geological survey of Pennsylvania, 1874. Report of progress in the district of York and Adams counties [etc., etc.].

Harrisburg, 1876, vol. C. pp. i-viii, 1-198, with 10 plates and maps.

Contains brief reports of observation on boundaries, dip, trap dikes, etc., pp. 71, 88-89, 91, 92-93, 94, 95, 101, 102, 103, 122-129, 152, 153, 159, 160, pls. op. pp. 64, 92, 94, 112, 128, 196.

FRAZER, PERSIFOR. 1876a.

Geological map of Adams county, Pa.

See Lesley and Frazer, 1876.

FRAZER, PERSIFOR, Jr. 1876b.

Notes on two traps; a case of alteration of earthy sediments.

In Philadelphia Acad. Nat. Sci., Proc., vol. 28, p. 60.

Describes the appearance of a sandstone that has been altered by a trap intrusion.

FRAZER, PERSIFOR. 1876c.

Notes on some Paleozoic limestones.

In Philadelphia Acad. Nat. Sci., Proc., vol. 28, pp. 60-63.

Gives an analysis of limestone from the Newark system at Dillsburg, Pa., p. 63.

FRAZER, PERSIFOR. 1876d.

A study of the specular and magnetic iron ores of the New Red sandstone in York county, Pa.

In Am. Inst. Mining Eng., Trans., vol. 5, pp. 132-143, pl. 2.

Describes the character and mode of occurence of certain iron ores and of associated trap dikes near Dillsburg, Pa.

FRAZER, PERSIFOR. 1876e.

A study of the igneous rocks.

In Am. Inst. Mining Eng., Trans., vol. 5, pp. 144-146.

Gives the mineralogical composition of a number of trap rocks from Adams and York counties, Pennsylvania, p. 146.

FRAZER, PERSIFOR, Jr. 1877.

Second geological survey of Pennsylvania, 1875. Report of progress in the counties of York, Adams, Cumberland and Franklin [etc., etc.].

Harrisburg [vol. CC], pp. 201-401, and 17 plates and maps.

Contains a detailed account of the Newark system in the counties mentioned, with special reference to the deposits of iron ore and to trap rocks. A large number of observations of dip are recorded, pp. 206-226, 239-317, 348-381, pl. op. pp. 222, 264, 272, 274, 298, 304, 328, and map.

FRAZER, PERSIFOR. 1877a.

The position of the American New Red sandstone.

In Am. Inst. Mining Engi., Trans., vol. 5, pp. 494-501.

Reviewed by P. Frazer in Am. Nat., vol. 13, pp. 284-292.

Compares a section of the Newark rocks in Adams county, Pennsylvania, with general sections of the Permian, Triassic, and Jurassic rocks of England and Germany.

FRAZER, PERSIFOR, Jr. 1877b.

On copper-bearing rocks of the Mesozoic formations.

In Philadelphia Acad. Nat. Sci., Proc., vol. 29, pp. 17-19.

Describes the occurrence of copper ore at Bonnaughton, near Gettysburg, Pa.

FRAZER, PERSIFOR. 877c.

Regarding some Mesozoic ores.

In American Phil. Soc., Proc., vol. 16, pp. 651-655.

Mentions outliers of schist in Newark areas, and also outliers of Newark rocks in the bordering crystalline rocks of Pennsylvania. Considers the mode of formation of the Newark sandstones, and advances a hypothesis to account for the ores they contain.

FRAZER, P. 1877d.

[Remarks on the Newark system in Pennsylvania.]

In Am. Phil. Soc., Proc., vol. 1-16, p. 664.

Brief abstract of remarks concerning the origin of the prevailing dip of the Newark rocks, and the occurrence of iron ores as a definite line in both the Newark and adjacent terranes.

FRAZER, PERSIFOR, Jr. 1878.

On the physical and chemical characteristics of a trap occurring at Williamson's Point [Pennsylvania].

In American Phil. Soc., Proc., vol. 18, 1880, pp. 96-103, and pl. op. p. 96.

Discusses the optical properties and the chemical and mineralogical composition of trap from the locality mentioned, and presents a complete analysis of it. The colored plate accompanying this paper shows the appearance of a thin section of the trap in polarized light.

FRAZER, PERSIFOR, Jr. 1879.

The Mesozoic sandstone of the Atlantic slope.

In Am. Nat., vol. 13, pp. 284-292.

A review of the following paper on the formation mentioned: "The position of the American New Red sandstone," by Persifor Frazer, jr.; "The Mesozoic formation of Virginia," by Oswald J. Heinrich; "Notes on the Mesozoic of Virginia," by Wm. M. Fontaine, and "The physical history of the Triassic formation of New Jersey and the Connecticut valley," by I. C. Russell.

FRAZER, PERSIFOR, Jr. 1880.

Second geological survey of Pennsylvania. Report of progress in CCC. [illegible]. The geology of Lancaster county.

FRAZER, PERSIFOR, Jr.—Continued.

Harrisburg, pp. i-x, 1-350, with 12 plates and an atlas of 13 sheets of maps and sections.

Contains a detailed description of the boundaries of the Newark system and of local features of the sandstone, conglomerate, trap dikes, etc., composing the system, in the county mentioned.

FRAZER, PERSIFOR. 1882.

Mémoire sur la géologie de la partie sud-est de la Pennsylvanie. In Thèses présentées à la Faculté des Sciences de Lille Université de France pour obtenir le grade de docteur ès-sciences naturelles. Lille [France], 4to, pp. 1-179, and 4 plates.

Contains a description of the Newark system in Pennsylvania. Describes the extent of the system, its geological position, the character and origin of the copper and iron ores it contains, and also the extent and character of the trap rocks that traverse it. Discusses briefly the origin of the red color of the Newark sandstone. Gives analyses of copper and iron ores, and of trap rock. The geological map shows the distribution of stratified and igneous rocks of Adams and Lancaster counties.

FRAZER, PERSIFOR. 1883.

Geological notes in the several townships of Chester county [Pa.].

In second geological survey of Pennsylvania, vol. C⁴, pp. 215-245 and maps in pocket.

Preliminary remarks on the varieties of rock in Chester county, including the sandstone, shale, and trap, p. 219. Distribution and general character of the Newark in various towns, pp. 220, 221, 222, 223, 224, 226, 235, 236, 244.

FRAZER, PERSIFOR. 1884.

Trap dikes in Archean rocks of southeastern Pennsylvania.

In Am. Phil. Soc., Proc., vol. 21, pp. 691-694.

A review of a paper by H. C. Lewis, on "A great trap dike across southeastern Pennsylvania." See Lewis, 1885.

FRAZER, PERSIFOR. 1885.

General notes, sketch of the geology of York county, Pa.

In Am. Phil. Soc. Proc., vol. 23, 1886, pp. 391-410, and a map.

Describes the extent and character of the Mesozoic rocks of York county, Pa. Discusses the evidence of their thickness and quotes E. D. Cope, in reference to their age.

FRAZER, P. Cited on amount of iron in trap rocks (Russell, '89, p. 51).

Cited on composition of trap rocks (W. M. Davis, '83, p. 284).

Cited on a great trap dike in southeastern Pennsylvania (Lewis, '85, p. 456).

Cited on intrusive trap sheets in Pennsylvania (W. M. Davis, '83, p. 294).

Cited on iron-ore mines near Dillsburg, Pa. (d'Invilliers, '86, pp. 1502).

FRAZER, P.—Continued.

Cited on trap dike in Pennsylvania (Lewis, '85, p. 444. Macfarlane, '79, p. 43).

Frederick, Md. Account of a search for coal near (Ducatel, '37, p. 36).

Occurrence of conglomerate south of (Lea, '53, p. 190).

Potomac marble from (Shaler, '84, p. 177).

Freedman ford, Va. Boundary of Newark near (Heinrich, '78, p. 235).

Freetown, P. E. I. Limestone near (Dawson and Harrington, '71, p. 34).

French cove, N. S. Minerals of (Gesner, '36, pp. 197, 198).

French cross, N. S. Description of (Gesner, '36, pp. 196-198).

French cross cove, N. S. Description of (Jackson and Alger, '33, pp. 248-251).

Frenchtown, N. J. Detailed description of sandstone and shale near (H. D. Rogers, '36, pp. 151, 152).

Dip near (Cook, 68, p. 198).

Dip of red shale near (Cook, '79, p. 29. Cook, '82, p. 27).

Fresh Kills, N. Y. Trap rock at (Cook, '68, p. 178).

Fritz mill, Pa. Detailed account of dips near (d'Invilliers, '83, p. 212).

Fritz island, Pa. Conglomerate from (d'Invilliers, '83, p. 392).

Fritz island mine, Pa. Detailed account of (d'Invilliers, '83, pp. 333-342).

GABB, WM. M. 1860.

Description of new species of fossils, probably Triassic, from Virginia.

In Philadelphia Acad. Nat. Sci., Jour., n. s., vol. 4, 1858-1860, pp. 307, 308.

Describes several species of mollusks from Bath county, Va. [Do not belong to the Newark system].

GABB, WM. M. 1861.

Illustrations of some fossils described in the proceedings of the [Philadelphia] Academy of Natural Science.

See Conrad and Gabb.

Gabel hill, Pa. Dip near (d'Invilliers, '83).

Trap dike (d'Invilliers, '83, pp. 200, 201).

Gabel mine, Pa. Analysis of ore from (d'Invilliers, '83, pp. 331-333).

Detailed account of (d'Invilliers, '83, pp. 327-333, maps in atlas).

Gale, (——). Cited on fossil fish from New Jersey (W. C. Redfield, '39).

Cited on the discovery of fossil fishes in New Jersey (Silliman, '39).

Gallas point, P. E. I. Analysis of limestone from (Dawson and Harrington, '71, p. 41).

Anticlinal at (Dawson and Harrington, '71, p. 16).

Description of (Dawson, '78, p. 116).

Description of fossil wood from (Dawson, '54).

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Reference to geology of (Chapman, '76, p. 92).

Gallas point, P. E. I.—Continued.

Section on (Dawson and Harrington, '71, p. 14).

Section through (Dawson and Harrington, '71, pl. —).

Gap nickel mine, Pa. Description of trap dike near (Frazer, '80, p. 80).

Gardenville, Pa. Trap dikes near (Lewis, '85, pp. 453, 454).

Gardner's, N. C. Exploration for coal near (Chance, '85, p. 46).

Gardner creek, N. B. Age of rocks at (Bailey, '65, p. 13, 124).

Dip at (Matthew, '63, p. 256. Matthew, '65, p. 124).

Erosion at (Gesner, '41, p. 15).

Extent of the Newark rocks at (Dawson, '78, p. 109).

Fossil wood from (Dawson, '63).

Geology of (Bailey, '72, pp. 217, 218. Matthew, '65).

Section near (Gesner, '41, p. 14).

Unconformity at (Matthew, '63, pp. 256, 258. Matthew, '65, p. 125).

Garret rock, N. J. Boundary of first mountain trap near (Cook, '68, p. 181).

Columnar trap (Cook, '84, p. 27).

Elevation of (Cook, '82, p. 49).

Fault near (Cook, '83, p. 25. Darton, '90, p. 23).

Lower contact of trap at (Darton, '90, p. 30).

Thickness of Watchung trap sheet at (Darton, '90, p. 21)

Gas pustules on sandstone of Connecticut valley (E. Hitchcock, '58, p. 168, pl. 55).

Gates mountain, N. S. Description of (Jackson and Alger, '33, pp. 245, 246).

Rocks of (Gesner, '36, p. 225).

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Gaylord's mine, Conn. Description of trap ridges near (Percival, 42, pp. 403, 404).

Gaylor mountain, Conn. Account of (Davis and Whittle, '89, pp. 105, 106).

Account of trap sheets near (Davis and Whittle, '89, pp. 116-118).

Contact of trap and sandstone near (W. M. Davis, '89b, p. 25).

Observations on the origin of (Davis and Whittle, '89, pp. 117-118).

Soft strata resting on trap sheet of (Davis and Whittle, '89, p. 103).

GEIKIE, ARCHIBALD. 1882.

Text-book of geology.

London, pp. i-xi, 1-971, pl. 1.

Contains a condensed résumé concerning the Triassic and Jurassic systems in North America, pp. 770, 800, 801.

GEIKIE, J. Cited on the faulting of a trap dike in southeastern Pennsylvania (Frazer, '84, p. 691).

GEINITZ [H. B.]. Cited on the age of the Newark rocks of Prince Edward island (Dawson, '74, p. 210).

Geneva, Ga. Trap dikes near (Loughridge, '84, p. 279).

Genito, Va. Boundary of the Newark near (W. B. Rogers, '40, p. 71).

GENTH, F. A. 1871.

On the mineral resources of North Carolina.

In Franklin Inst. Jour., vol. 62 (Dec., 1871).

Describes briefly the coal and coal fields of North Carolina.

GENTH, FREDERICK A. 1881.

Analysis of minerals and rocks from Bucks, Montgomery, and Philadelphia counties, Pa.

In Second Geological Survey of Pennsylvania, report of progress, vol. CC, pp. 94-136.

Contains analysis of trap rocks from New Hope, Mount Pleasant, Quakertown, Brownsburg, etc., and an analysis of limestone from Morrisville, Pa., pp. 94-99, 111, 133-134.

GENTH, F. A. Analysis of coal from North Carolina (Williams, '85, p 59).

Analysis of iron ores (d'Invilliers, '88, pp. 338-339).

Analysis of iron ore by (Kerr, '75, p. 232).

Analysis of trap from the Cornwall iron mines, Pa. (Lesley and d'Invilliers, '85).

Analysis of trap from near Gettysburg, Pa., by (Frazer, '77, pp. 309-312).

An analysis of trap from Williamsons point, Pa. (Frazer, '78).

Analysis of trap rock from Gulf Mills, Pa. (C. E. Hall, '81, pp. 133, 134).

Analysis of trap rock from near York, Pa., by (Frazer, '75a, pp. 408-409).

Analysis of trap rock from Point Pleasant, Pa. (Lewis, '85, p. 454).

Cited on analysis of coal from Gulf, N. C. (Chance, '85, p. 42).

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General section of Newark rocks near (Jones, '62, p 89).
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Southern limit of Newark area near (Olmsted, '27).

Germantown, N. J. Boundaries of Newark system near (Cook, '89, p. 11).
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Halifax, N. S. 12mo, pp. i-xl, 1-265, pl. 2 and a map.
In this report pages 71-101 are devoted to a description of the "red sandstone district," in which the author includes the Newark areas proper, and also much of the region about the basin of Mines, which is now known to be Carboniferous (see map accompanying Dawson's Acadian Geology). Pages 169-265 are devoted to a description of the "trap district," in which all the trap outcrops of the province receive attention. In this portion of the report considerable space is devoted to the description of the occurrence of minerals in the trap.

GESNER, ABRAHAM. 1839.
First report on the geological survey of the province of New Brunswick. St. John [N. B.], 12mo, pp. 1-87.
Devoted principally to a description of the geology of the coast of New Brunswick between St. Andrews and St. John. In this and in four subsequent reports by the same author the Newark and other systems have not been separately described, but treated as new red sandstone. For this reason but few references to the report in question will be found in this catalogue. For more recent reports on the region referred to see "Observations on the geology of southern New Brunswick," by L. W. Bailey, 1865, and a report on the new red sandstone or Trias in the same volume; also geological map accompanying J. W. Dawson's Acadian Geology, and "Map of the Dominion of Canada, 1842 to 1882," accompanying a "Descriptive sketch of the physical geography and geology of the Dominion of Canada," by A. R. C. Selwyn and G. M. Mason, Montreal, 1884.

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St. John [N. B.], 12 mo, p. i-xii, 1-72.
Contains a description of the Newark rocks of Quaco Head. Other localities where rock is found supposed by Gesner to belong to the Newark system are also described. (See Gesner, '39).

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St. John [N. B.], 12 mo, pp. i-xiv, 1-83.
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St. John [N. B.], 12 mo, pp. 1-101.
Contains brief references to strata that are called New Red sandstone, pp. 64, 88.

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GESNER, ABRAHAM. 1843a.
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St. John [N. B.], 12 mo, pp. 1-88.
Contains a table showing the geological position of the red sandstone (Newark) and the character of the strata composing it. Also an account of the rocks referred to the New Red sandstone period, pp. 54, 61-63.

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The industrial resources of Nova Scotia.

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Halifax, N. S., pp. 1-111, 1-341, 1-17, 1-4, map and plate.
Contains a brief account of the Newark sandstones and trap rocks of Nova Scotia.

GESNER, A. Cited on age of the Newark rocks of Nova Scotia (Dawson, '78, p. 109).
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Cited on geology of Blomidon, N. S. (Marsters, '90).

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Exfoliation of trap rock near (Frazer, '74*a*).
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Mention of trap and other rock specimens from (C. E. Hall, '78, pp. 27-68).
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Occurrence of copper ore near (Frazer, '77*b*).
Optical properties of rock from near (Frazer, '75*a*, p. 410).
Picture of Devil's Den near (Frazer, '80, pl. 9).
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Graham's coal mine, Va. Brief account of (Macfarlane, '77, p. 507).

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A general account of the working and economic value of the coal mines of Chesterfield county, Va.

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Sketch, showing coal outcrop near (Chance, '85, p. 38).

Thickness of Newark rocks at (Emmons, '56, p. 231).

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Description of sandstone at (Cook, '68, p. 208).

Elevation of (Russell, '80, p. 36).

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CONTENTS.

	Page.
Introduction	227–228
Geographical distribution of the Mesozoic formation in Virginia, its outlines and area	228–239
The eastern division	229
The middle eastern division	229–232
Taylorsville deposit	229–230
Springfield deposit	230
Richmond deposit	230–232
The middle western division	232
Aquia deposit	232–233
Farmville deposit	233–235

HEINRICH, OSWALD J.—Continued.

CONTENTS—continued.

	Page.
The west division	235–239
Potomac deposit	235–236
Barboursville deposit	236–237
James river deposit	237
Danville deposit	237–239
Description of the rocks constituting the formation	239–245
Conglomerate	239–240
Sandstones	240–242
Slates and shales	242–243
Limestones	243
Coal	243–244
Igneous rocks	244
Accessory minerals	344–245
General geological and stratigraphical characters of the formation	245–264
Detailed section at Old Midlothian coal mine	256–260
Section at Carbon hill	260
Fossil remains of the formation	264–266
Economic products of the formation	266–274

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Discussion of the origin of (Hovey, '89, p. 381).

Henderson, Pa. Boundary of the Newark near (C. E. Hall, '81, pp. 22, 84).

HENDERSON, J T. 1885.

The commonwealth of Georgia.

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HENDERSON, J. T.—Continued.
Contains a brief account of the Newark system in North and South Carolina, and states that trap dikes probably belonging to the same system occur in Georgia.

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[Explanation of the accumulation of matter in the center of raindrop impressions.]
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Heth's (pit), Va. Analysis of coal from (Williams, '83, p. 82).

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Hickorytown, Pa. Boundary of the Newark near (C. E. Hall, '81, pp. 72–73. Lesley, '85, p. lxxxi).

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Sketch map of a portion of (W. M. Davis, '89, pl. 3).
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View of, to illustrate structure (W. M. Davis, '89c, p. 426).

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Shales beneath trap sheet near (Darton, '90, p. 28).
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High torne, N. Y. Contact of trap and sandstone beneath (Darton, '90, p. 50).

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Hillsboro, N. C. Breadth of Newark rocks near (Olmstead, '24, p. 12).
Decomposition of trap dikes near (Burbank, '73, p. 151).

Hill's coal mine, Va. Brief account of (Macfarlane, '77, p. 507).
Notes on (Taylor, '35, p. 284).
Thickness of coal in (Taylor, '35, p. 282).

Hinkletown, Pa. Boundary of the Newark near (Frazer, '80, pp. 15, 46. H. D. Rogers, '58, vol. 2, p. 668).

Hitchcock cabinet, Amherst college, Mass. Descriptive catalogue of footprints in (C. H. Hitchcock, '65).

HITCHCOCK, CHARLES H. 1855.
Impressions (chiefly tracks) on alluvial clay, in Hadley, Mass.
In Am. Jour. Sci., 2d ser., vol. 19, pp. 391–396.
Describes a number of recent footprints and other markings, and in a footnote, p. 392, states briefly some of the various views that have been advanced in reference to the age of the Connecticut valley sandstone.

HITCHCOCK, CHARLES H. 1859.
[Report on copper mine at Flemington, New Jersey.] See Hitchcock, E., and C. Hitchcock, 1859.

HITCHCOCK, CHARLES H. 1865.
Preface [to supplement to the Ichnology of New England.]
In supplement to Ichnology of New England, by Edward Hitchcock, pp. ix–x.
Relates to the publication of the "supplement," and to specimens of footprints at Amherst college.

HITCHCOCK, CHARLES H. 1865a.
Descriptive catalogue of specimens in the Hitchcock ichnological cabinet at Amherst college.
In supplement to the Ichnology of New England, by Edward Hitchcock, pp. 41–93.
Describes specimens of footprints, and gives localities from which they were derived.

HITCHCOCK, CHARLES H. 1866.
Description of a new reptilian bird from the Trias of Massachusetts.
In New York Lyc. Nat. Hist., Ann., vol. 8, 1867, pp. 301–302.
Describes the footprints of Tarsodactylus expansus, from near Turners Falls, Mass.

HITCHCOCK, CHARLES H. 1867.
Elementary geology.
See Hitchcock and Hitchcock, 1867.

HITCHCOCK, CHARLES H. 1871.
Geological description [of Massachusetts].

HITCHCOCK, CHARLES H.—Continued.
In official topographical atlas of Massachusetts, by H. F. Walling and O. W. Gray. Boston, folio, pp. 17-23, and map.
Contains a brief sketch of the general geology of the state, accompanied by a colored geological map; also a list of fossil footprints found in the Newark system.

HITCHCOCK, CHARLES H. 1874.
The Coal Measures of the United States.
In statistical atlas of the United States, by Francis A. Walker, pp. 12-14, pls. 11, 12.
Contains a brief account of the coal fields of eastern Virginia and of North Carolina. Accompanied by two maps, one (pl. XI) showing the distribution of coal fields and the other (pl. XII) a general geological map of the United States, compiled by C. H. Hitchcock and W. P. Blake.

HITCHCOCK, CHARLES H. 1877.
The relation of the geology of New Hampshire to that of the adjacent territory.
In the geology of New Hampshire, by C. H. Hitchcock, vol. 2, pp. 3-36, pl. op. p. 8.
Contains a brief reference to the Newark rocks of the Connecticut valley, Nova Scotia, New Brunswick, etc. These areas are shown on the map op. p. 8.

HITCHCOCK, CHARLES H. 1877a.
Geology of the Connecticut valley district [of New Hampshire].
In geology of New Hampshire. Concord, vol. 2, 4to, pp. 271-407, 428-462, and 7 plates.
Refers briefly to the position of the north end of the Connecticut valley area, and the presence of a heavy conglomerate in Northfield, Mass.

HITCHCOCK, CHARLES H. 1881.
Geological map of the United States, compiled by C. H. Hitchcock.
New York. Published by Julius Bien.
A wall map; scale 20 miles to an inch.
Map, geological, of the United States (C. H. Hitchcock, '81).

HITCHCOCK, CHARLES H. 1886.
The geological map of the United States.
In Am. Inst. Mining Eng., Trans., vol. 15, pp. 465-488, map op. p. 486.
Contains an account of previously published geological maps of the United States and Canada, and shows the distribution of the Jurassic and Triassic systems of the United States.

HITCHCOCK, CHARLES H. 1888.
Recent progress in ichnology.
In Boston Soc. Nat. Hist., Proc., vol. 24, pp. 117-127.
Presents a revised list of the footprints of the Newark system, and gives descriptions of several new species. Notices also the localities where footprints have been found in New Jersey and Pennsylvania.

HITCHCOCK, CHARLES H. 1889.
[Remarks on a paper by Atreus Wanner, concerning the discovery of fossil tracks in the Newark rocks of York county, Pa.]

HITCHCOCK, CHARLES H.—Continued.
In Am. Assoc. Adv. Sci., Proc., vol. 37, p. 186.
States that fossil footprints recently discovered in rocks of the Newark system of New Jersey and Pennsylvania belong to the same genera as the tracks previously discovered in the Connecticut valley.

HITCHCOCK, CHARLES H. 1890.
The use of the terms Laurentian and Newark in geological treatises.
In Am. Geol., vol. 5, pp. 197-202.
Reviewed by I. C. Russell in Am. Geol., vol. 7, pp. 238-241.
A review of a paper on "The Newark System," by I. C. Russell. Gives reason for objecting to the use of "Newark" as a group name, pp. 200-202.

H[ITCHCOCK], C. H. Description of Grallator gracilis by (E. Hitchcock, '65, p. 8, pl. 9).
Note on Anomœpus gracillimus (E. Hitchcock, '65, p. 6).
Plants collected by. in the Newark system (Newberry, '88, p. 92).
Remarks on Brontozoum giganteum by (E. Hitchcock, '65, p. 23).
Remarks on the origin of the Connecticut valley sandstone (Whitney, '60).

HITCHCOCK, C. H., and W. P. BLAKE. 1874.
Geological map of the United States.
In Statistical atlas of the United States, based on the Ninth Census, 1870 [etc.], by Francis A. Walker, pls. 13-14.
First published in the reports of the Ninth Census of the United States, by F. A. Walker. Appeared also in the statistics of mines and mining, by R. W. Raymond, 1873; in "Special report on the Smithsonian Institution for the Centennial," Washington, 1876; and in "Atlas of the United States and the World," by Gray, Philadelphia, 1877.
A compiled map showing the distribution of geological formations in the United States.

H[ITCHCOCK], EDWARD. 1815.
Southampton lead mine and basaltic columns at Mount Holyoke, Mass.
In North American Review, vol. 1, pp. 334-338.
A popular letter on the subjects referred to in the title.

HITCHCOCK, EDWARD. 1818.
Remarks on the geology and mineralogy of a section of Massachusetts on Connecticut river, with a part of New Hampshire and Vermont.
In Am. Jour. Sci., vol. 1, pp. 105-116, 436-439, and map.
Describes in general terms the geology in the neighborhood of Mounts Holyoke and Tom, Mass., pp. 105, 108, and map.

HITCHCOCK, EDWARD. 1823.
A sketch of the geology, mineralogy, and scenery of the region contiguous to the river Connecticut; with a geological map and drawings of organic remains; and occasional botanical notices.

HITCHCOCK, EDWARD—Continued.

In Am. Jour. Sci., vol. 6, 1823, pp. 1-86, 201-236, pl. 9, and map op. p. 86; vol. 7, 1824, pp. 1-30, pl. 1.

Describes the Newark rocks of the Connecticut valley, in part under the name of the Old Red sandstone, vol. 6, pp. 39-42. The "greenstone dikes" in the Old Red sandstone are described on pp. 56-59, and their origin discussed on pp. 59-61. Another division of the Newark receives attention under the name of the "Coal formation," pp. 61-80. In vol. 7 the scenery of the Connecticut valley is described, and in this connection the relief of several trap hills receives attention.

H[ITCHCOCK], E[DWARD]. 1824.

Notice of a singular conglomerate, and of an interesting locality of trap tuff, or tufa.

In Am. Jour. Sci., vol. 8, pp. 244-247.

Describes exposures of trap tuff on the east side of Mount Tom, Mass.

HITCHCOCK, EDWARD. 1824a.

A geological and agricultural survey of the district adjoining the Erie canal in the State of New York, part 1, containing a description of the rock formations; together with a geological profile; extending from the Atlantic to Lake Erie.

Albany. 12mo, pp. 1-163, pls. 1-2.

The sections accompanying this report show the positions of the Newark rocks and associated traps of the Connecticut valley.

HITCHCOCK, EDWARD. 1828.

Miscellaneous notices of mineral localities, with geological remarks.

In Am. Jour. Sci., vol. 14, pp. 215-230.

Refers briefly to an exposure of sandstone beneath trap on the east side of Mount Holyoke, Mass., p. 218, and records a few facts concerning the small outlying Newark area in Woodbury and Southbury, Conn., pp. 227-228.

HITCHCOCK, EDWARD. 1832.

Report on the geology of Massachusetts; examined under the direction of the government of that state, during the years 1830 and 1831.

In Am. Jour. Sci., vol. 22, pp. 1-70, and map op. p. 1.

Contains a brief account of the sandstone along the Connecticut river, but refers principally to its value as a building stone. The formation is termed the New Red sandstone.

HITCHCOCK, EDWARD. 1835.

Report on the geology, mineralogy, and botany of Massachusetts, in four parts; Part I, Economic geology; Part II, Topographical geology; Part III, Scientific geology; Part IV, Catalogue of animals and plants. Amherst, 1835. Second edition, corrected and enlarged, pp. i-xii, 13-702, accompanied by 4to atlas of 19 plates.

HITCHCOCK, EDWARD—Continued.

First edition of Part I, Economic geology, Amherst, 1832, pp. 1-70, and geological map of Massachusetts.

First edition of full report, Amherst, 1833, pp. i-xii. 1-692, and 4to atlas of 19 plates.

The contents of the 2d ed., so far as it relates to the Newark system, is as follows:

	Page.
Newark system of Massachusetts briefly described	20
Greenstone (trap) division briefly described	23-24, 31
Discovery of limestone in the Connecticut valley	38-39
Building stone briefly described	46-47
Coal	53-54
Copper ores	71-72
Detailed account of the Newark system	211-251
Mineral character of the sandstone	213-219
Topography of the red sandstone	220-222
Dip, direction, and thickness of the strata	222-228
Mineral contents	228-234
Copper	228-229
Coal	229-232
Lead, zinc, and iron	232-233
Iron sand	233
Rotten stone	233
Satin spar	233
Sulphate of baryta	233
Sulphate of strontia	234
Sulphate of lime	234
Organic remains	234-243
Animal remains	237-243
Ichthyolites	238-239
Mollusca	239
Zoöphyta	239-242
Radiaria	242-243
Theoretical considerations	243-251
Greenstone (trap) described	398-434
Mineralogical characters	399-431
Hornblende and feldspar	399
Columnar	399-402
Compact	402
Chiefly greenish compact feldspar	402
Indurated clay	402
Hornblende, Augite? and feldspar	403
Porphyritic	403-404
Amygdaloidal	404-405
Concreted	405
Tufaceous	405
Topography of greenstone (trap)	405-410
Situation of greenstone (trap) in relation to other rocks	411-421
Chemical effects of greenstone (trap) upon other rocks	421-425
Mineral contents	425-431
Theoretical considerations	431-434
The resemblance in external character between some varieties of our greenstones and the products of existing volcanoes	431-332

HITCHCOCK, EDWARD—Continued. Page.

- Greenstone (trap) described—Continued.
  - Theoretical considerations—Continued.
    - The columnar structure of greenstone 432
    - The irregular manner in which greenstone is intruded among stratified rocks 432
    - The mechanical effects of greenstone upon the stratified rocks 432–434
- Unconformity of the Newark system with primary strata 510
- The trap system 513–514
- Catalogue of specimens from the Newark system 655–657
- Catalogue of specimens of trap 669–670

HITCHCOCK, EDWARD. 1836.

Ornithichnology. Description of the footmarks of birds (Ornithichnites) on New Red sandstone in Massachusetts.

In Am. Jour. Sci., vol. 29, pp. 307–340, and 3 plates.

Abstract in Neues Jahrbuch, 1836, pp. 467–472.

Refers to early discussion of fossil footprints in Massachusetts, mentions several localities at which they occur, discusses the nature of the animals that made the tracks, and describes and figures several species.

HITCHCOCK, EDWARD. 1837.

Researches in theoretical geology by H. T. De La Beche, with a preface and notes by Prof. Edward Hitchcock.

New York. 12mo, pp. i-xv, 1–342.

Contains a note on the fossil fishes of the Connecticut valley, p. 267, and also on the fossil footprints of the same region, pp. 271–273.

HITCHCOCK, EDWARD. 1837a.

Fossil footsteps in sandstone and graywacke.

In Am. Jour. Sci., vol. 32, pp. 174–176.

Abstract in Neues Jahrbuch, 1837, pp. 602–603.

Mentions the advance that has been made in the study of the fossil footprints of the Connecticut valley and gives a list of species described.

HITCHCOCK, E. 1837b.

Ornithichnites in Connecticut.

In Am. Jour. Sci., vol. 31, pp. 174–175.

Brief mention of additional localities in Connecticut at which fossil footprints have been found. The footprints are described briefly and their names given in some instances.

HITCHCOCK, EDWARD. 1841.

Final report on the geology of Massachusetts.

Northampton, 4to, vol. 1, pp. i-xii, 1a–11a, 1–299, pls. 1–14 and a map; vol. 2, pp. 300–831, pls. 15–55.

The contents of this report, so far as it relates to the Newark system, is as follows:

HITCHCOCK, EDWARD—Continued. Page

- A reprint of a report by H. D. Rogers, L. Vanuxem, R. C. Taylor, E. Emmons, and T. A. Conrad, of the Association of American Geologists, on the Ornithichnites or footmarks of extinct birds in the [Newark system] of Massachusetts and Connecticut, observed and described by Prof. Hitchcock, of Amherst 2a–3a
- Coal in the Connecticut valley 138–143
- Trap rocks (greenstone) for building.. 152–153
- Sandstone quarries 180–181
- Rocks suitable for whetstones and grindstones 213–214
- Rocks suitable for flagstones 214
- Scenographic geology 241–249
  - Mount Holyoke 241–243
  - Titan's pier 243–244
  - Titan's piazza 244–246
  - Mount Tom 246–247
  - Sugar Loaf 247–248
  - Mount Toby 248–249
  - Valley of the Connecticut 256–259
  - Turners Falls 275–277
  - Holyoke falls 277–278
  - South Hadley Falls 284–285
  - The gorge or glen in Leyden 285–286
- A tabular view of the rocks of Massachusetts 303
- The Newark system (New Red sandstone) described 434–450
  - Lithological characters 441–446
    - Conglomerate 441–442
    - Tufaceous conglomerate 442
    - Sandstone 442–443
    - Shale 443
    - Limestone 444–446
  - Topography of the formation 446–447
  - Dip, strike, and thickness of the strata 447–448
  - Mineral contents 448–449
  - Organic remains 449–528
    - Vegetable remains 450–458
    - Animal remains 458–464
  - Fossil footmarks 464–528
    - Localities 465–467
    - A general description of the nature and situation of the fossils 467–474
    - Specific description of the footmarks 474–501
    - Impression of raindrops 501–503
  - Fossil bones 503–504
  - Tracks of living animals 504–508
  - Conclusion from all the facts 508–525
  - Artesian wells 525
  - Theoretical considerations relating to the formation generally. 526–531
- Greenstone (trap) 641–663
  - Lithological character 641–645
    - Hornblende and feldspar 641
    - Columnar trap 641–643
    - Compact trap 643
    - Indurated clay 644

HITCHCOCK, EDWARD—Continued. Page.

Greenstone (trap)—Continued.
  Lithological character—Continued.
    Amygdaloidal trap 644–645
    Concreted trap 645
    Tufaceous trap 645
  Topography of the greenstone (trap) 646–650
  Situation of the greenstone in relation to other rocks 650–656
    Dikes of greenstone 655–656
  Chemical effects of greenstone on other rocks 657–660
  Mineral contents of greenstone (trap) 660–663
Newark system 712
Catalogue of specimens from the Newark system 804–806
Catalogue of specimens of greenstone (trap) 819–820

HITCHCOCK [EDWARD]. **1841a.**

[Remark on joints and fractures in the sandstone and trap of the Connecticut valley.]

In Am. Jour. Sci., vol. 41, p. 173, and also in Am. Assoc. Geol. and Nat., Proc., p. 25.

Brief abstracts of remarks on a paper, by Prof. Mather, concerning joints in rocks.

HITCHCOCK, EDWARD. **1841b.**

First anniversary address before the Association of American Geologists, at their second annual meeting at Philadelphia, April 5, 1841.

In Am. Jour. Sci., vol. 41, pp. 232–275.

States briefly the geographical distribution of the Newark system and discusses the question of its age, pp. 244–245. The "New Red sandstone system" is mentioned on p. 267.

HITCHCOCK [EDWARD]. **1842.**

On a new species of Ornithichnite from the valley of the Connecticut river, and on the raindrop impressions from the same locality.

In Am. Jour. Sci., vol. 43, p. 170; also in Am. Assoc. Geol. and Nat., Proc., p. 63.

Title of paper only, followed by remarks by Charles Lyell and H. D. Rogers, W. B. Rogers, Benjamin Silliman, jr. [C. W.] Redfield, and John L. Hayes.

HITCHCOCK, EDWARD. **1843.**

The phenomena of drift, or glacio-aqueous action in North America, between the Tertiary and Alluvial periods.

In Am. Assoc. Geol. and Nat., Trans., pp. 164–221, pls. 7, 8, 9.

Describes briefly the general geology and topographical features of the region about Mount Tom and Mount Holyoke, Mass.

HITCHCOCK, EDWARD. **1843a.**

Description of five new species of fossil footmarks, from the Red sandstone of the valley of Connecticut river.

In Am. Assoc. Geol. and Nat., Trans., pp. 254–264, pl. 11.

Devoted principally to the description of new species of footprints, obtained near Turners Falls, Mass., by James Deane.

HITCHCOCK, EDWARD. **1843b.**

Description of several species of fossil plants, from the New Red sandstone formation of Connecticut and Massachusetts.

In Am. Assoc. Geol. and Nat., Trans., pp. 294–296, pls. 12, 13.

Describes briefly the character of the rocks forming the small Newark area at Southbury, Conn., and gives the results of a microscopical examination of a specimen of fossil wood found there. Fragments of fossil ferns from localities in Massachusetts are also briefly described.

HITCHCOCK [EDWARD]. **1844.**

The trap tufa or volcanic grit of the valley of the Connecticut river, with inferences as to the relative age of the trap and sandstone.

In Am. Jour. Sci., vol. 47, pp. 103–104.

Abstract of remarks describing the character of the tufa, method of its formation, etc.

HITCHCOCK [EDWARD]. **1844a.**

Report on ichnolithology, or fossil footmarks, with a description of several new species, and the coprolites of birds, from the valley of the Connecticut river.

In Am. Jour. Sci., vol. 47, pp. 292–322, pls. 3, 4. Abstract ibid., pp. 113–114; also in, Neues Jahrbuch, 1845, pp. 753–757.

Reviews the discussion of the question of first discovery of fossil footprints in the sandstone of the Connecticut valley, describes several new species of footprints, and discusses the nature of certain coprolites.

HITCHCOCK, EDWARD. **1844b.**

Discovery of more native copper in the town of Whately, in Massachusetts, in the valley of Connecticut river, with remarks on its origin.

In Am. Jour. Sci., vol. 47, pp, 322–323.

Describes the occurrence of a mass of native copper in the drift at the locality mentioned.

HITCHCOCK, EDWARD. **1844c.**

Geological map of Massachusetts: Scale 5 miles to 1 inch, or $\frac{1}{316800}$, 1844.

On wall map of Massachusetts.

HITCHCOCK, EDWARD. **1844d.**

[On priority in the discovery of fossil footmarks in the sandstone of the Connecticut valley.]

In Am. Jour. Sci., vol. 47, pp. 390–399.

Devoted to the question of priority in the discovery of the footprints in question.

HITCHCOCK, EDWARD. **1844e.**

Explanation of the geological map attached to the topographical map of Massachusetts.

Boston, 12mo, pp. 1–22.

Contains a brief description of trap and trap-tuff or tufaceous conglomerate occurring in the Connecticut valley, and also refers to the distribution of the Newark sandstone in the same region.

HITCHCOCK, EDWARD. 1845.

An attempt to name, classify, and describe the animals that made the fossil footmarks of New England.

In Am. Assoc. Geol. and Nat., Proc., sixth meeting, pp. 23-25.

Presents a list of families, genera, and species of the animals that made the footprints in the Newark rocks of the Connecticut valley. A revised classification based on a new set of measurements.

HITCHCOCK, EDWARD. 1845a.

Remarkable facts respecting the magnetic polarity of trap rocks in New England.

In Am. Assoc. Geol. and Nat., Proc., sixth meeting, p. 32.

Brief abstract of a paper recording observations on the magnetic attraction of the trap rocks of the Connecticut valley.

HITCHCOCK, EDWARD. 1845b.

Analysis of coprolites from the New Red sandstone of New England.

See Dana, S., and E. Hitchcock, 1845.

HITCHCOCK, EDWARD. 1845c.

[Miscellaneous remarks upon fossil footmarks.]

In Am. Jour. Sci., vol. 48, pp. 62-64.

Brief remarks on very large footprints found principally in Northampton, Mass.

HITCHCOCK, EDWARD. 1847.

Description of two new species of fossil footmarks found in Massachusetts and Connecticut, or of the animals that made them.

In Am. Jour. Sci., 2d ser., vol. 4, pp. 46-57.

Describes two new genera of footprints, represented by a single species each, from South Hadley, Mass. Discusses also the conditions under which the footprints in the sandstone of the Connecticut valley were made.

HITCHCOCK, EDWARD. 1847a.

On the trap tuff, or volcanic grit of the Connecticut valley, with the bearing of its history upon the age of the trap rock and sandstone generally in that valley.

In Am. Jour. Sci., 2d ser., vol. 4, pp. 199-207.

Describes the lithological characters of the various trappean rocks of the Connecticut valley, explains the structure of mounts Tom and Holyoke, and the topography of the trap ridges; also considers certain organic remains associated with the trap; discusses the mode and the period of the production of the trap.

HITCHCOCK, EDWARD. 1848.

An attempt to discriminate and describe the animals that made the fossil footmarks in the United States, and especially New England.

In Am. Acad., Mem., n. s., vol. 3, pp. 129-256, pls. 1-24, and a table op. p. 256.

Discusses the principles on which animals are classified from their footprints. Describes large number of genera and species. The matter contained in this paper is embodied in Hitchcock's later work on the "Ichnology of New England," 1858.

HITCHCOCK, EDWARD—Continued.

HITCHCOCK [EDWARD]. 1853.

[Remarks on the fossil footprints of the Connecticut valley.]

Boston Soc. Nat. Hist., Proc., vol. 4, pp. 375-379.

Gives an account of a measured section across the Connecticut valley, showing a great thickness of strata. Thickness of rock above the highest footprint found is also stated. Considers that the dip of the sandstone containing footprints has not been caused by the intrusion of trap. Infers that the entire thickness of sandstone can not all belong to the Newark system.

HITCHCOCK, EDWARD. 1855.

Description of several sections measured across the sandstone and trap of Connecticut river valley in Massachusetts.

In Am. Assoc. Adv. Sci., Proc., vol. 9, 1856, pp. 225-227.

Describes briefly the principal facts resulting from the measurement of three sections across the Connecticut valley, located at Turners Falls, Mount Tom, and Chicopee, Mass. The thickness of the rocks is stated as well as their probable age.

HITCHCOCK, EDWARD. 1855a.

Elementary geology.

New York, 30th ed., 12 mo, pp. i-xviii, 19-424, pl. 1.

Earlier editions not noted.

Gives a brief account of columnar trap at Mount Holyoke, Mass., pp. 87-88.

Describes briefly the footprints and rain drop impressions of the Connecticut valley sandstones, pp. 181-190. Discusses the age of the Newark system, pp. 407-409.

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Additional facts respecting the tracks of the Otozoum Moodii on the Liassic sandstone of the Connecticut valley.

In Am. Assoc. Adv. Sci., Proc., vol. 9, 1856, p. 228.

Describes certain features of the tracks mentioned, and states localities at which they have been discovered.

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Outlines of the geology of the globe.

Boston, 3d ed., pp. 1-136, pls. 1-6, and two maps.

Contains a short account of the Newark system and a brief discussion of its probable age, pp. 66-99.

HITCHCOCK, EDWARD. 1856a.

Description of a new and remarkable species of fossil footmark, from the sandstone of Turners Falls, in the Connecticut Valley. [Part 2 of an article entitled "On a new fossil fish, and new fossil footmarks.]

In Am. Jour. Sci., 2d ser., vol. 21, pp. 97-100.

Abstract in Neues Jahrbuch, 1856, pp. 237-238.

Describes the genus Gigandipus, and the species *G. caudatus*.

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[On some regular, polygonal depressions found in the sandstone of the Connecticut valley.]

In Boston Soc. Nat. Hist., Proc., vol. 6, 1856–1859, p. 111.

Brief description of the depressions, with the statement that they might have been made by tadpoles.

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Ichnology of New England. A report on the sandstone of the Connecticut valley, especially its fossil footmarks, made to the government of the commonwealth of Massachusetts.

Boston, 4to, pp. i-vii, 1-220, pls. I-LX.

Reviewed in Am. Jour. Sci., 2d ser., vol. 27, pp. 270–272.

Abstract in Neues Jahrbuch, 1859, and in Am. Jour. Sci., 2d ser., vol. 27, pp. 270–272.

The following is an abstract of the contents of this volume, as given on pages v–viii:

	Page.
Bibliography of North American fossil footmarks.	ix
History of the subject	1–5
Geological position of the Connecticut river sandstone	5
Geological sections across the Connecticut valley	9–13
Dip and strike of the strata	10
Varieties of rock	10
Thickness of the strata	11
Inferences from the sections	13
Mode in which the sandstone has been elevated	15
Mode in which the trap rock has been introduced into the sandstone	17
Final conclusions as to the age and equivalency of the Connecticut river sandstone	20–22
Characters in the feet of animals constant and distinctive, illustrated by the study of the feet and footprints of living animals	24–45
Names and classification of the Lithichnozoa, or footmark animals	46
Detailed descriptions of groups and species	48–54
Localities where footprints have been obtained in the Connecticut valley	49
Group 1. Marsupialoid animals	54–60
Group 2. Pachydactylous or thick-toed birds	63–80
Group 3. Leptodactylous or narrow-toed birds	80–93
Group 4. Ornithoid lizards or batrachians	93–107
Group 5. Lizards	107–129
Group 6. Batrachians	121–138
Group 7. Chelonians	138–144
Group 8. Fishes	144–147
Group 9. Crustaceans, myriapods, and insects	147–160
Group 10. Annelids	160–165
Opinions of zoologists and anatomists as to the character of some of the invertebrate tracks	165
[Contains observations by J. D. Dana, Joseph Leidy, and Louis Agassiz.]	
Tabular view of the Lithichnozoa	201–205
Other phenomena connected with or illustrating the footmarks	166–172
Impressions of raindrops	166
Gas pustules	168
Ripple marks	168
Septaria	169
Sun cracks and mud veins	169
Fucoids and other fossil plants	170
Tracks of recent animals and raindrops on clay	170
Results and conclusions as to the circumstances under which the footmarks were formed	172–174
Synoptical view of the species and kinds of animals	174
A more popular description of the footmark animals in the several groups	175–190
Controversial	191–199
Glossary	207

The plates accompanying this volume are as follows:

	Plate.
Sketch of the Moody footmark quarry, South Hadley, Mass	1
Ichno-geological map of the Connecticut valley	2
Sections across the Connecticut valley	3
Appleton cabinet, exterior and interior views of	4
Plant and shell in sandstone	5
Tracks of living animals, etc	6
Plants, footprints of living animals, etc.	7
Outline drawings of fossil footprints	8–21
Shaded lithograph of footprints of Otozoum	22
Outline drawings of fossil footprints and other markings	23–31
Footprint of boy and of a bird, etc	32
Outline drawings of fossil footprints	33–37
Shaded lithograph of fossil footprints, etc	38–60

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[Catalogue of rocks, minerals, and fossils in the Massachusetts state cabinet.

In sixth annual report of the secretary of the Massachusetts Board of Agriculture [etc.], Boston, 1859, appendix, pp. i-lxix.

Contains a list of specimens, including samples of rock, fossil plants, fossil fishes, and footprints, from the Newark system in Massachusetts and Connecticut.

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Supplement to the Ichnology of New England.

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CONTENTS.

	Page.
Letter from the author	vii-viii
Preface by the editor [C. H. Hitchcock]	ix-x
Additions to the ichnological cabinet at Amherst college	1
Species described in Ichnology of New England which are not reliable	2
List of species that are considered doubtful	2
Descriptions of new species	2-22
Tracks of insects	13-17
Tracks of myriapods	17-18
Trails of annelids	18-19
Specimens of doubtful origin and character	19-22
Miscellaneous items	22-34
Brontozoum giganteum, description of	23-25
Phalanges of some of the Lithichnozoa	25-28
J. D. Dana's views concerning the footprint animals	33-34
Postscript	35-37
Bones of Megadactylus polyzelus	39-40
Descriptive catalogue of the specimens in the Hitchcock ichnological cabinet at Amherst college, by C. H. Hitchcock	41-88
Additional observations concerning Exocampe minima, by C. H. H.	89
Description of plates	91-93

Plates 1-12, 20, are lithographs, and remainder are photographs.

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Cited on fossil footprints from the Connecticut valley (Deane, '45, pp. 159, 160, 161, 166, 167. D'Orbigny, '49, vol. 1, pp. 27-32. Gray and Adams, '60, pp. 247-252. Lea, '53, pp. 185, 186, 187, 188, 189, 193-194. Lyell, '66, pp. 453-456. Lyell, '71, p. 361. Owen, '59, pp. 325-327. Pictet, '53, vol. 1, p. 403. W. C. Redfield, '38. H. D. Rogers, '58, vol. 2, p. 694. Russell, '78, p. 231. Winchell, '70, pp. 182-185).

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Cited on the number of joints in the toes of fossil footprints (Silliman and Dana, '47).

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Cited on the origin of the trap of Connecticut (Hovey, '89, p. 376).

Cited on the original horizontal deposition of the sandstones of the Connecticut valley (Wurtz, '70, p. 100).

Cited on peculiar raindrop impressions (Anonymous, '39).

Cited on the relation of trap and sandstone in the Connecticut valley (Stodder, '57. W. M. Davis, '83, p. 285).

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Notice of work by (Miller, '79-'81, vol. 2, pp. 146-147, 148, 152, 153, 154).

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Referred to in connection with fossil footprints (Macfarlane, '79, p. 63).

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Work of, referred to (C. H. Hitchcock, '71, p. 20).

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Presents a brief general account of the geological position of the mine referred to, with character of rock, ore, etc.

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Table showing geological classification, p, 43. Trap rock at Mount Holyoke, p. 87. Fossil fern from East Hampton, Mass., p. 295. Brief account of the footprints and raindrop impressions of the sandstones of the Connecticut valley, pp. 309-320. Older Mesozoic systems briefly discussed, pp. 415-416.

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Cited on the discovery of fossil fern at Mount Tom, Mass. (Wells, '56).

Discoveries relative to the age of the Connecticut valley sandstone (2 Hitchcock, '58, p. 6).

Hoboken, N. J. Bored well in (Ward, '79, p. 132).

Boundary of trap outcrop at (Cook, '68, p. 177).

Description of indurated shales near (Darton, '83*a*).

Dip in sandstone at (Cook, '82, p. 24).

Faults in trap ridge near (Darton, '90, pp. 42, 43, 44).

Lower contact of trap sheet near (Darton, '90, p. 44).

Possible origin of the arkose near (D. S. Martin, '83).

Section of trap ridge near (Darton, '90, p. 44).

Trap at (Credner, '65, pp. 392-394).

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Mention of trap rock on (Chapman, '76, p. 92. Chapman, '78, p. 121. Dawson and Harrington, '71, p. 21. Dawson, '72, p. 203),

Hog island, P. E. I.—Continued.

Trap rock on (Dawson, '78a, pp. 29, 31. Dawson, '78, p. 123. Ells, '84, p. 18E).

Hohokus, N. J. Conglomerate at (Cook, '82, p. 41).

Dip at (Cook, '68, p. 195).

Dip in sandstone at (Cook, '79, p. 30. Cook, '82, p. 24).

Sandstone quarry at (Cook, '79, p. 21).

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Holland, Mass. Description of trap dikes in primary rocks in (Percival, '42, pp. 419-420).

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Contact of sandstone and trap near (W. M. Davis, '83, p. 262).

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Section at, showing junction of amygdaloid and sandstone (W. M. Davis, '83, pp. 305-307, pl. 10).

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See, also, Mount Holyoke.

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Mention of building stone near (Cook, '81, p. 43).

Sandstone quarries at (Cook, '79, p. 21).

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HOOKER [J. D.]. 1847.

[Note of vegetable structure in coal from the Richmond coal field, Virginia.]

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Hook mountain, N. J. Analysis of trap from (Cook, '68, p. 217).
- Building stone of (Cook, '68, p. 505).
- Course of (Cook, '82, p. 19).
- Description of (Cook, '68, p. 186. Cook, '82, pp. 54–55).
- Dip at (Cook, '68, p. 196).
- Dip of sandstone at (Cook, '79, p. 30. Cook, '82, p. 30).
- Long hill supposed to be a continuation of (Cook, '82, pp. 56–57).
- Sandstone quarry at (Cook, '79, p. 22).

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- Description of (Darton, '90, p. 38).
- Dip of sandstone at (Cook, '79, p. 32).
- Faults near (Nason, '89, pp. 25–26).
- Sandstone at east base of (H. D. Rogers, '40, pp. 134–135).
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Hooper's mill, Pa. Conglomerate and trap from (C. E. Hall, '78, p. 45).

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- Dip of shale near (Cook, '68, p. 709. Cook, '82, p. 26).
- Exceptional dip near (Nason, '89, p. 18).
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- Section of coal seams near (Emmons, '52, p. 124).

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- Dip at (E. Hitchcock, '36, p. 312).
- Early discovery of fossil footprints at (E. Hitchcock, '36, p. 308).

Horse race, Mass.—Continued.
- Locality for fossil footprints (E. Hitchcock, '41, p. 465. E. Hitchcock, '48, p. 131).
- Special characters of footprints from (E. Hitchcock, '41, p. 469).

Horshamville, Pa. Trap dike near (Lewis, '85, p. 441).

Horton, N. C. Quality of coal found at (Emmons, '52, p. 131).

Horton, N. S. Section from, to cape Blomidon (Dawson, '78, pp. 90–94).
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Horton's, J. L., coal mine, N. C. Analysis of black-band ore from (Willis, '86, p. 306).
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- On the Virginias; their agricultural mineral, and commercial resources.
- In Soc. Arts., Jour. [London], vol. 21, pp. 238–251.
- Contains a brief account of the Richmond coal fields, pp. 339–340.

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- The production of coal in the United States, by coal fields, for the census year ending June 1, 1880.
- In The Virginias, vol. 3, p. 13.
- Gives the amount of coal produced from the Newark system in Virginia and North Carolina during the year mentioned.

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House's quarry, N. C. Conglomerate at (Emmons, '56, pp. 237-238).
Conglomerate in (Wilkes, '58, p. 5).
Fossil plants from (Emmons, '56, pp. 328-329. Emmons, '57, pp. 119-132).

HOVEY, A. H. Opening of copper mine by (Cook, '81, p. 39).

HOVEY, EDMUND OTIS. 1889.
Observations on some of the trap ridges of the East Haven-Bradford region.
Am. Jour. Sci., 3d ser., vol. 38, pp. 361-383, pl. 9.
Abstract in Am. Assoc. Adv. Sci., Proc., vol. 38, pp. 232-233.
Contents: The topography of the region. Its trap belts and sandstone ridges. Position and forms of the trap belts. Particular description of Pond rock, and ridges east of it. Kinds of trap rock in different parts of the region. The amygdaloid, and its relation to that which is nonvesicular. The relation of the sandstone to the trap. Contact phenomena. Main theories which have been advanced to account for the occurrence of the trap. Special discussion of the theory of "contemporaneous overflow." The age of the trap. Concludes that all of the traps in the region described are intrusive.

HOVEY, E. O. Cited on coarse deposits in Connecticut (J. D. Dana, '90).

HOW, HENRY. 1861.
On gryolite occurring with calcite in apophyllite in the trap of the bay of Fundy.
In Am. Jour. Sci., 2d ser., vol. 32, pp. 13-14.
An analysis of gryolite is given.

HOW, HENRY. 1869.
The mineralogy of Nova Scotia.
Halifax, N. S. Pp. 1-217.
A brief description is given of the occurrence of copper ore on the shores of the bay of Fundy and the Minas basin, pp. 65-66, and at Indian point and Five island, p. 72. A catalogue of mineral localities on pp. 202-208 contains numerous references to Newark localities.

HOW, HENRY. 1875.
Contributions to the mineralogy of Nova Scotia.
In Philo. Mag., 4th ser., vol. 41, 1871, pp. —, 274, 5th ser., vol. 1, 1876, pp. 128-138.
Describes minerals from the trap rocks of Nova Scotia. Refers to the similarity in the traps of the Newark system from Nova Scotia to North Carolina. Gives specific gravities of certain trap rocks.

HOWE, A. B. 1876.
On gmelinite from Nova Scotia.
In Am. Jour. Sci., 3d ser., vol. 12, pp. 270-274.
Describes mineral mentioned; gives localities and analysis.
Analysis of minerals composing trap rocks (Hawes, '82, pp. 131-132).
Cited on mineral analysis of trap rock from Bergen hill, N. J. (Shaler, '84, p. 145).

HOWELL, M. A. Trap rock quarried by (Cook, '81, p. 62).

Howellville, Pa. Trap dike near (Lewis, '85, p. 444).

HUBBARD, OLIVER P. 1842.
Chemical examination of a large sample of bituminous coal from the pits of the Midlothian coal mining company, south side of James river, 14 miles from Richmond, Va., in Chesterfield county.
Silliman and Hubbard, 1842.

HUBBARD, OLIVER P. 1850.
The condition of trap dikes in New Hampshire an evidence and measure of erosion.
In Am. Jour. Sci., 2d ser., vol. 9, pp. 158-171.
States the amount of erosion that has taken place in the Connecticut valley and describes certain trap rocks in New Hampshire that are perhaps of the same age as the similar rocks of Massachusetts, etc., p. 170.

HUBBARD, OLIVER P. 1885.
Two varieties of the New Red sandstone used for building in New Haven, Conn.
In New York Acad. Sci., Trans., vol. 5, 1885-1886, pp. 12-13.
Refers briefly to the mineralogical composition and dip of a ridge of sandstone in East Haven, Conn., and to the durability of building stone derived from it.

HUBBARD, O. P. 1889.
[Note concerning a bored well near New Haven, Conn.]
In New York Acad. Sci., Trans., vol. 9, p. 3.
Gives the depth of a well bored by the Winchester Arms Co.

HUBBARD [O. P.]. Analysis of coal from the Richmond coal field, Va. (Clifford, '87, p. 10).

Hudson county, N. J. On the geology of (Russell, '80).

Hudson river. Boundary of trap outcrop along (Cook, '68, p. 177).

Hugh's mill, Pa. Detailed account of dips (d'Invilliers, '83, p. 212).

HULL, EDWARD. 1881.

On the coal fields of Great Britain; their history, structure and resources.

London, 4th ed., pp. i-xviii, 1-556, and 15 plates.

Contains a brief note on the Richmond coal field, Va., p. 460.

HULL, EDWARD. 1887.

A sketch of geological history [etc., etc.].

London, 12mo, pp. i-xv, 1-179, and 1 plate.

Contains a brief account of the Triassic and Jurassic periods in North America, pp. 85-87, 94-95.

Hull P. O., Pa. Trap from near (C. E. Hall, '78, p. 44).

Hummelstown, Pa. Boundary of the Newark near (Frazer, '82, p. 123).

Brownstone quarries. Description of (d'Invilliers, '86, pp. 1564-1565).

Sandstone quarries of (G. P. Merrill, '89, p. 459. Shaler, '84, p. 156).

Humphreysville, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 417-419).

Hungary station, Va. Boundary of Newark area near (Heinrich, '78, p. 230).

HUNT, JOSEPH H. 1890.

A group of copper pseudomorphs after chalcocite, and silica and phrenite pseudomorphs after pectolite, from Paterson, N. J.

In New York Acad. Sci., Trans., vol. 9, pp. 140-144.

Describes briefly the rocks exposed near Paterson, N. J.

HUNT, T. STERRY. 1874.

Remarks of the stratification of rock masses.

In Boston Soc. Nat. Hist., Proc., vol. 16, 1873-1874, pp. 237-238.

Refers to a sample of banded diorite from New Jersey. Opposes the opinion of H. Wurtz, in reference to the indigenous origin of the trap rock of New Jersey.

HUNT [T. STERRY]. 1875.

[Remarks on natural coke in the Richmond coal field, Va.]

In The Engineering and Mining Journal, vol. 19, p. 35.

Remarks following the reading of a paper on deep borings with a diamond drill, read by O. J. Heinrich before the American Institute of Mining Engineers, Dec. 26, 1874. States that the natural coke or carbonite of the Richmond coal field, according to an analysis by P[illegible] Wurtz, contains too much volatile m[illegible] to be classed as coke. Remarks on the same subject were made by M. Coryell and O. J. Heinrich.

HUNT, T. STERRY. 1876.

The Cornwall iron mine and some related deposits in Pennsylvania.

In Am. Inst. Mining Eng., Trans., vol. 4, pp. 319-325.

States that certain iron ores in Pennsylvania referred by various observers to the Mesozoic are of older date, p. 320. Refers to trap dikes which may belong to the series of dikes and sheets traversing the Newark system, p. 321.

HUNT, T. STERRY. 1876a.

Geology of eastern Pennsylvania.

In Am. Assoc. Adv. Sci., Proc., vol. 25, 1877, pp. 208-212.

Refers briefly to the passage of metamorphic rocks beneath the Newark system in Pennsylvania.

HUNT, T. STERRY. 1879.

Table of the geological formations [of North America].

In an American geological railway guide, by James Macfarlane, p. 51.

Makes the Newark system the equivalent of the Jurassic and Triassic.

HUNT, THOMAS STERRY. 1883.

The geological history of serpentines, including notes on pre-Cambrian rocks.

In Canada Roy. Soc., Proc. and Trans., vol. 1, sec. 4, pp. 165-215.

The Newark rocks of Staten island, N. Y., are incidentally described.

HUNT, T. STERRY. 1883a.

The decay of rocks geologically considered.

In Am. Jour. Sci., 3d ser., vol. 26, pp. 190-213.

Refers briefly to the origin of copper in the Newark system of Connecticut, New Jersey, and Pennsylvania.

HUNT, T. S. Cited on the origin of certain ores along the borders of the Newark rocks of Pennsylvania (Frazer, '77c).

Hunterdon copper mine, N. J. Dip and metamorphism in (Dickeson, '59, p. 8).

Report on (Dickeson, '59. E. and C. H. Hitchcock, '59).

Hunterstown, Pa. Trap dikes near (H. D. Rogers, '58, vol. 2, p. 688).

Huntington, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 416-417).

Huyler's landing, N. J. Conglomerate at (Cook, '68, p. 208).

Ichnological map of the Connecticut valley. (E. Hitchcock, '58, pl. 2).

Idaville, Pa. Trap from (C. E. Hall, '78, p. 45).

Ideal section. Illustrating the mode of formation of shore conglomerate (Russell, '78, p. 235).

Illustrating the use of "overflow." After J. P. Lesley (W. M. Davis, '83, p. 281, pl. 9).

Intrusive trap sheet. After I. C. Russell (W. M. Davis, '83, p. 281, pl. 9).

Trap sheet (Russell, '80, p. 42).

IDDINGS, JOSEPH P. 1886.

The columnar structure in the igneous rocks on Orange mountain, New Jersey.

;EPH P.—Continued.

ur. Sci., 3d ser., vol. 31, pp. 321–331,

in Washington Philo. Soc., Bull., pp. 19–24.

an exposure of columnar trap near e N. J., and discusses the origin of lumnar structure in igneous rocks.

N. J. Dip in shale at (Cook, '82, p.

N. S. Copper ores at (How, '69, p.

beneath trap at (Dawson, '78, p.

(Dawson, '47, p. 52).

s near (Ells, '85, p. 7E).

P. E. I. Sections at (Dawson and igton, '71, pp. 17–18).

;, Pa. Description of a fault near ;, '85, p. 451).

rints of. On Connecticut valley one (Warren, '55).

l, from sandstone of Connecticut (J. D. Dana, '58). E. Hitchcock, . 147–166).

ccount of (Scudder, '68, pp. 218–220).

n (J. D. Dana, '62).

, from Phœnixville, Pa. Mention ieatley, '61*a*).

(Scudder, '86).

ns made by, from Turners Falls, (E. Hitchcock, '56, p. 111. E. ock, '58, pp. 7–8).

from the Connecticut valley, re- on (Scudder, '67).

discovered (E. Hitchcock, '65, pp. pls. 6, 7, 14, 18, 24, 27, 29, 30).

N. J. Dip in shale at (Cook, '82, p.

s of (Cook, '82, p. 18).

'ossils. Description and discussion nes, '62).

n of the tracks of (E. Hitchcock, . 18–19.

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E. V. d'. 1883.

ological survey of Pennsylvania, re- f progress, D3, vol. 11, pt. 1. The y of the South mountain belt of county.

g, pp. i–xxii, 1–441, pl. 4, and 6 in atlas.

escriptions, with many observations of the Newark system in the region ed to, pp. 48–50, 127, 159, 197–226, 239, 2, 344–348, 351, 353, 380, 382, 387, 392, aps in atlas.

E. V. d'. 1885.

a the Cornwall iron ore mines, on county [Pa.].

r and d'Invilliers. 1885.

INVILLIERS, E. V. d'. 1886.

Report on the iron ore mines and limestone quarries of the Cumberland-Lebanon valley [Pennsylvania].

In annual report of the geological survey of Pennsylvania for 1886, pt. 4, pp. 1411-1567, with 7 maps.

Contains an account of iron mines near Dillsburg, pp. 1501-1514, and of sandstone quarries in Lebanon valley, pp. 1563-1567.

INVILLIERS, E. V. d'. 1886a.

The Cornwall iron ore mines, Lebanon county, Pa.

In Am. Inst. Mining Eng., Trans., vol. 14, pp. 873–904, pl. op. p. 874.

Contains an account of dikes of trap rock and their association with iron ore deposits, pp. 876–879; also a description of the stratified rocks of the Newark system exposed at Cornwall, pp. 890–892.

Native, in trap rock of New Jersey (Cook, '74, pp. 56–57).

On the occurrence of, at Berlin, Conn. (E. Hitchcock, '35, p. 232).

Iron in Massachusetts. Brief account of (E. Hitchcock, '41, pp. 448–449).

Iron in North Carolina. Analyses of (Kerr, '75, pp. 225–230. Willis, '86, pp. 305–306).

Brief account of (Anonymous, '66, p. 108. Chance, '85, p. 24).

At Egypt (Emmons, '56, p. 262).

At Gulf (Emmons, '56, p. 262).

Brief account of (Emmons, '57*a*, pp. 9–11. W. R. Johnson, '51, p. 20).

In Dan river coal field (Emmons, '52, p. 154).

In Deep river coal field (Emmons, '52, p. 124. Emmons, '56, pp. 262–265. Olmstead, '24, p. 22. Wilkes, '58, pp. 12–17).

Iron Hill, Pa. Trap dikes near (Lewis, '85, p. 453).

Iron, native, in trap rock of New Jersey (Cook, '74, pp. 56–57).

On the occurrence of, at Berlin, Conn. (E. Hitchcock, '35, p. 232).

Iron ores in Nova Scotia. At Blomidon (Gesner, '36, p. 217).

Brief account of (Harrington, '74, pp. 207, 219. Alger, '27).

In the trap rocks, determination of (How, '75, vol. 1, pp. 136–137).

Near Digby (Jackson and Alger, '33, pp. 235–236).

Iron ore in Pennsylvania. (Frazer, 77*a*, pp. 500–501. Frazer, '82, pp. 129, 135. d'Invilliers, '83, pp. 320–352. H. D. Rogers, '39, p. 22. H. D. Rogers, '58, vol. 1, pp. 86, 87, 88).

Age of, discussed (T. S. Hunt, '76, p. 320. H. D. Rogers, '58, vol. 2, p. 691).

Brief account of (d'Invilliers, '83, p. 239. H. D. Rogers, '58, vol. 2, p. 763.)

Near Cornwall. Detailed description of (Lesley and d'Invilliers, '85).

Near Dillsburg. Discussion concerning (Frazer, '77, pp. 317–331, pl. op. p. 328).

Near Dillsburg. Study of (Frazer, '76*d*).

Iron ore in Pennsylvania—Continued.
Discussion of the origin of (Frazer, '82, pp. 135-139).
Report on (Frazer, '77, pp. 207-239).
Near Dillsburg and Wellsville. Analysis of (Frazer, '77, pp. 232-237).
Near Emmettsburg and Fairfield. (H. D. Rogers, '58, vol. 2, p. 691).
Near Gettysburg. Exploration for (Frazer, '77, pp. 263-264).
Near Maria Furnace. (H. D. Rogers, '58, vol. 2, p. 690).
Near Petersburg (H. D. Rogers, '58, vol. 2, p. 690).
Notice of, in York county (Frazer, '85, p. 404).
Origin of (Frazer, '77*c*).
Remarks on the occurrence of (Frazer, '77*d*).

Iron ore in South Carolina. Near Cornwells, brief reference to (Tuomey, '48, p. 68).

Iron ore in Virginia. Brief account of (Heinrich, '78, p. 245. W. B. Rogers, '80, p. 152).
Résumé concerning (Frazer, '82, p. 171).

Ironstone station, Pa. Contact metamorphism at (d'Invilliers, '83, p. 199).
Detailed account of dips (d'Invilliers, '83, p. 212).

Isle Haute, N. S. Description of (Gesner, '36, p. 229. Jackson and Alger, '33, pp. 259-262).
Trap of (Dawson, '78, p. 108).

JACKSON, CHARLES T. **1837.**
First report on the geology of the State of Maine.
Augusta. 12mo, pp. i-viii, 10-190, accompanied by an atlas of 24 plates.
Certain rock in Maine which are traversed by trap dikes are described in this report as being of the age of the "New Red sandstone," but more recent investigations have shown them to be of older date. (The trap dikes of this region may possibly belong to the Newark system of intrusions.) Cross references to this report are not given in the present index.

JACKSON, CHARLES T. **1841.**
First annual report on the geology of the State of New Hampshire.
Concord, N. H. 12mo, pp. i-iv, 5-164.
Describes the occurrence of Newark rocks in Northfield, Mass., and considers the mode of formation of the Connecticut valley sandstone. The Newark rocks of the Connecticut valley, exclusive of the intrusive rocks, do not extend north of the Massachusetts-New Hampshire boundary.

JACKSON, C. T. **1841a.**
[Remarks on joints in the trap dikes of Nova Scotia.]
In Am. Jour. Sci., vol. 41, p. 173; also in Am. Assoc. Geol. and Nat., Proc., p. 26.
Abstract of remarks on a paper by Prof. Mather concerning joints in rocks.
Calls attention to the columnar structure of larger trap masses and the prevalence of a similar structure from side to side in small dikes. Refers these phenomena to manner of cooling.

JACKSON, C. T. **1845.**
Nature of the minerals accompanying trap dikes which intercept various rocks.
In Am. Assoc. Geol. and Nat., Proc., 6th meeting, pp. 28-31.
States that several systems of trap dikes occur in New England. Describes briefly those intersecting the Connecticut valley sandstone and notes the metamorphic effects produced on contiguous stratified beds.

JACKSON, C. T. **1850.**
[On the age of certain sandstones of the United States.]
In Boston Soc. Nat. Hist., Proc., vol. 3, pp. 335-336, 337-338.
Brief statement in reference to the supposed age of the sandstone of lake Superior, and of the sandstone of the Connecticut valley, New Jersey, etc. It is suggested that the latter may belong to the Silurian system. The occurrence of trap in the Connecticut valley is briefly described.

JACKSON, C. T. **1850a.**
Analysis of red marl from Springfield, Mass.
In Am. Assoc. Adv. Sci., Proc., vol. 4, pp. 337-338.
Presents an analysis of a highly ferruginous marl or shale adjacent to trap rock.

JACKSON, C. T. **1853.**
[Age and structure of the Deep river coal field, N. C.]
In Am. Acad., Proc., vol. 3, 1852-1857, pp. 68-69.
A brief abstract of remarks relating to the structure and possible age of the coal field mentioned. Followed by brief remarks by W. B. Rogers and L. Agassiz.

JACKSON, CHARLES T. **1853a.**
Sur les mines de cuivre et de houille de la Caroline du Nord.
In Geol. Soc. Trans. Bull., 2d ser., vol. 10, 1852-1853, pp. 505-506.
Extract from a letter to M. Delesse, giving a brief account of the Deep river coal field, N. C. Refers the rocks containing coal to the New Red sandstone. Cites Rogers and Agassiz in reference to the age of the Richmond coal field.

JACKSON, C. T. **1855.**
[On raindrop impressions in footprints.]
In Boston Soc. Nat. Hist., Proc., vol. 5, p. 189.
Remark on a paper by J. C. Warren.

JACKSON, C. T. **1855a.**
[On the identity in age of the coal-bearing rocks of Virginia and North Carolina.]
In Boston Soc. Nat. Hist., Proc., vol. 5, p. 186.
Remarks on a paper by W. B. Rogers. Suggests that the rocks of the Newark system may be the equivalent of the Lias of Europe.

JACKSON, C. T. **1856.**
[Trap dikes in relation to Zeolite minerals, native copper, etc.]
In Boston Soc. Nat. Hist., Proc., vol. 6, pp. 23-24.
Reference to the agency of trap rocks in producing various minerals.

JACKSON, CHARLES T. **1856a.**
[On the Deep river coal field, N. C.]
In Boston Soc. Nat. Hist., Proc., vol. 6, pp. 30–83.
Brief account of an exploration for coal near Egypt, N. C., with a section of the coal-bearing strata near the bottom of the Egypt shaft. Analyses of coal are given; also the result of some experiments in reference to the value of the coal for gas-making.

JACKSON [C. T.]. **1856b.**
[Remark on unconformable interruption.]
In Boston Soc. Nat. Hist., Proc., vol. 6, p. 184.
Mentions the occurrence of the Newark of the Connecticut valley resting on gneiss, granite, etc., as an illustration of interruption where the whole Paleozoic group is wanting.

JACKSON, C. T. **1859.**
[Note on the copper mines, so called, at Elk run, Fauquier county, Va.]
In Am. Assoc. Adv. Sci., Proc., vol. 6, 1856–1859, p. 183.
Brief statement of the occurrence of copper minerals in trap dike breaking through sandstone.

JACKSON, C. T. **1859a.**
[Amygdaloid minerals of the Nova Scotia and lake Superior traps.]
In Boston Soc. Nat. Hist., Proc., vol. 7, p. 46.

JACKSON, C. T. **1860.**
[On the age of the red sandstone of Perry, Me.; Nova Scotia; Keweenaw point, Mich.; Connecticut valley, etc.]
In Boston Soc. Nat. Hist., Proc., vol. 7, p. 396–398.
The sandstones at the various localities mentioned are briefly compared and certain general conclusions inferred as to their age.

JACKSON [C. T.]. Cited on the age of the Newark system (Lea, '53, pp. 185, 188. W. C. Redfield, '51).
Cited on analysis of coal from North Carolina (Genth, '71).
Cited on the extent of Triassic rocks in America (Archaic, '60, pp. 634–636, 646–655).

JACKSON, CHARLES T., and FRANCIS ALGER. **1828-1829.**
A description of the mineralogy and geology of a part of Nova Scotia.
In Am. Jour. Sci., vol. 14, 1828, pp. 305–330; map op. p. 305, vol. 15, 1829, pp. 132–160, pls. 1–2.
This paper was published with additions as "Remarks on the mineralogy and geology of Nova Scotia," in Am. Acad., Mem., n. s., vol. 1, 1833, and appeared as an independent publication under the title "Remarks on the mineralogy and geology of the peninsula of Nova Scotia; Cambridge, 1832, 4to. See Jackson, Charles T., and Francis Alger, 1833.

JACKSON, CHARLES T., and *FRANCIS ALGER.* **1833.**
Remarks on the mineralogy and geology of Nova Scotia.
In Am. Acad., Mem., n. s., vol. 1, pp. 217–330, pl. 4, and map.
Issued separately as "Remarks on the mineralogy and geology of the peninsula of Nova Scotia." Cambridge, 1832, 4to, pp. 1-116, pls. 1-4, and map. Published originally as "A description of the mineralogy and geology of a part of Nova Scotia" in Am. Jour. Sci., vol. 14, 1828, pp. 305–330, and map op. p. 305, vol. 15, 1829, pp. 132–160, pls. 1–2.
Reviewed by C. Moxon, in The Geologist [London], vol. 1, 1842, pp. 301–306.
Describes the trap outcrops along the east shore of the bay of Fundy and on the shore of Minas basin, etc. The presence of amygdaloid beneath trap at many localities is noted, and also the metamorphism of sedimentary rocks beneath the amygdaloid. A large portion of the report is devoted to describing the occurrence of minerals in the trap. The Newark sedimentary rocks are not clearly separated from similar Carboniferous rocks.

JACKSON and ALGER. Cited on lignite in Nova Scotia (Dawson, '78, p. 99).
Cited on the relation of trap and sandstone in Nova Scotia (W. M. Davis, '83, p. 285).
Cited on the trap of Nova Scotia (Beaumont, '34, pp. 247–248.

JACKSON, J. B. S. **1854.**
[Remarks on fossil footprints.]
In Boston Soc. Nat. Hist., Proc., vol. 5, 1854–1856, p. 30.
Brief remarks in discussion of a paper by Bouvé.

Jacksonville, N. J. Course of trap ridge near (Cook, '82, p. 55).
Description of conglomerate near (Kitchell, '56, pp. 144, 145).

Jacksonwald, Pa. Dip of strata, and exposure of trap near (d'Invilliers, '83, pp. 217-218, 219, 220).
Prevailing dip near (d'Invilliers, '83, p. 49).
Sandstone and trap at (d'Invilliers, '83, p. 203).
Trap dikes near (d'Invilliers, '83, pp. 200, 201).

JAMES, JOSEPH F. **1889.**
On variations; with special reference to certain Paleozoic genera.
In Am. Nat., vol. 23, pp. 1071-1087.
Refers to *Dendrophycus triassicus*, and states that it is probably an inorganic marking.

JAMES, THOMAS P. **1876.**
Handbook of the State of Georgia.
Atlanta, Ga., pp. i–vii, 1–256, and a geological map of Georgia.
Contains reference to trap dikes, pp. 38, 40, and map.

Jarrettown, Pa. Trap dike near (Lewis, '85, p. 441.

Jefferson, N. J. Dip near (H. D. Rogers, '40, pp. 129–130).
Sandstone and trap exposed near (H. D. Rogers, '40, pp. 129–130).

Jelliff's mill, N. J. Analysis of trap from (Cook, '68, p. 218).
Dip at (Cook, '68, p. 198).

Jennersville, Pa. Trap dike near (Lewis, '85, p. 447).

Jericho hill, N. J. Detailed account of (Darton, '90, pp. 59–61).
Dip of Newark rocks near (Lewis, '85, p. 455).
Origin of (Darton, '89, p. 138).
Trap dike near (Lewis, '85, p. 454).

Jersey City, N. J. Analysis of trap rock from (Hawes, '75).
Base of Newark system reached in wells (Darton, '89, p. 139).
Bored well in (Cook, '80, p. 172. Cook, '82, pp. 139–141. Cook, '85, p. 118. Ward, '79, pp. 131–132).
Boundary of trap outcrop at (Cook, '68, p. 177).
Character of trap ridge near (Darton, '90, p. 38).
Description of the geology near (W. M. Davis, '83, pp. 271–272).
Faults in trap ridge near (Darton, '90, p. 42. Nason, '89, p. 26).
Junction of sandstone and gneiss at (Cook, '68, p. 247).
Mineralogical analysis of trap rock from (Hawes, '82, p. 131. Shaler, '84, p. 145).
Quarries of trap rock near (Cook, '81, pp. 60–61).
Mention of (S. P. Merrill, '89, p. 435).
Section from, to Boonton, N. J. (Cook, '85, pl. op. p. 109).
Section from, to fort Lee, N. Y. (Cozzens, '43, pl. 2).
Section from, to Morris plains, N. J. (Cook, '68, p. 199, and map in portfolio).
Section of trap sheet at (Darton, '90, p. 42).
Trap exposed at (Credner, '65, pp. 392–394. Russell, '80, p. 37. Ward, '79, p. 150).

Jewell's, T., quarry near Princeton, N. J. Description of (Cook, '81, p. 55).

Jewitt & Bros.' colliery, Va. Analysis of coal from (Clifford, '87, p. 10).
Brief account of (Clifford, '87, pp. 11, 13–14).
Trap dike near (Clifford, '88, p. 252).

Jobogue point, N. S. Dikes at (Honeyman, '85, p. 123).

JOHNSON, JOHN. 1848.
[Remark on shrinkage cracks at Middletown, Conn.]
In Am. Jour. Sci., vol. 45, p. 315.
Brief remark on a paper by W. C. Redfield.

JOHNSON, JOHN. 1854.
Notice of some spontaneous movements occasionally observed in the sandstone strata in one of the quarries at Portland, Conn.
In Am. Assoc. Adv. Sci., Proc., vol. 8, 1855, pp. 283–286. See, also, National Magazine, vol. 3, 1853, p. 362.
Notice, with subsequent observations by W. H. Niles, Boston Soc. Nat. Hist., Proc., vol. 14, p. 86.

JOHNSON, JOHN—Continued.
Describes certain movements in the quarries mentioned which follow the cutting of trenches across the strata.

JOHNSON, JOHN. Cited on movements in the rocks at Portland, Conn. (Niles, '70, p. 86).

JOHNSON, W. C. 1839.
[Description of the Richmond coal field.]
In report of the committee on a national foundry, Doc. 168, p. 41. Not seen.

JOHNSON, WALTER R. 1842.
[Analysis of natural coke from the Richmond coal field, Va.]
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Treated under the following heads:
"Natural coke" from Tuckahoe, Va., pp. 138–151.
Artificial coke from Midlothian coal, pp. 52–156.
Bituminous coal from Deep Run mines, pp. 309–327.
Bituminous coal from Crouch and Snead's mines, Henrico county, Va., pp. 325–337.
Bituminous coal from the mines of the Midlothian Coal Company, taken from shaft 900 feet deep, pp. 338–348.
Bituminous coal from the Creek Coal Company, Chesterfield county, pp. 349–362.
Bituminous coal from the Clover hill mines, on the Appomattox river, Virginia, pp. 363–377.
Bituminous coal from the Chesterfield Mining Company, Chesterfield county, Va., pp. 378–389.
Bituminous coal of average size sent by the Midlothian Coal Company, Virginia, pp. 390–404.
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Bituminous screened coal from the minings of the Midlothian Coal Company's "new shaft," pp. 420–431.
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Synoptical view of the characters, composition and efficiency of Virginia bituminous coals, table CLIV, pp. 448–451.

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Detailed description of calcareous conglomerate near (H. D. Rogers, '40, pp. 140-141).
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JONES, RUPERT T. 1862a.
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Notice of a fossil plant found by (Chapin, '91*a*).

Kennett, Pa. Mention of a trap dike in (Frazer, '84, p. 693).

Kensington, Conn. Brief account of geology near (Percival, '22).

Mention of fossil plants having been found near (Percival, '42, p. 442).

Kentville, N. S. Dip at (Dawson, '47, p. 56).

Unconformity at base of the Newark near (Dawson, '78, p. 92).

Kentville, Pa. Boundary of the Newark area of Pennsylvania near (Lea, '58, p. 92).

KERR, W. C. **1867.**

Report of the progress of the geological survey of North Carolina. 1866.

Raleigh. Pp. 1-56.

Refers briefly to coal, oil, fire clays, etc., in North Carolina, pp. 20, 46-47.

KERR, W. C. **1869.**

[Report of the progress of the geological survey of North Carolina, for the years 1866-1867.]

[Raleigh, N. C.]. Pp. 1-57.

States the failure to find sufficient phosphate of lime in the black shales associated with the coal seams of Deep river to be of economic importance. pp. 9-10.

KERR, W. C. **1874.**

Observations on the Mesozoic of North Carolina.

In Am. Assoc. Adv. Sci., Proc., vol. 23, 1875, pp. 47-49.

Compares briefly the characteristic features of the Newark rocks of North Carolina and of the Connecticut valley, and presents a brief account of the leading facts in the stratigraphy of the entire Newark system; discusses the probable structure and former extent of the formation.

KERR, W. C. **1875.**

Report of the geological survey of North Carolina. Physical geology, résumé, economic geology.

Raleigh [N. C.]. Vol. 1, pp. i-xviii, 1-325, 1-120, pl. 9, and a folding map.

Notice in Am. Jour. Sci., 3d ser., vol. 11, pp. 61-62.

Republished in part in "In the Coal and Iron Counties of North Carolina," by P. M. Hale, pp. 52-53.

The following is an expansion of the table of contents of this volume, so far as it relates to the Newark system:

	Page.
Geological charts showing stratigraphic position of Triassic rocks	x, 110-111
Newark system in North America, sketch of	116-117

KERR, W. C.—Continued.

	Page.
Newark system in North Carolina	141-147
Dan river belt	141, 145
Deep river belt	141, 143
Former connection of Deep river and Dan river areas	[illegible]
Dip in Deep river and Dan river areas	141
Coal	141, 143
Conglomerate	141
Section at Egypt shaft	142
Thickness	145
Area	146
Origin of material	146
Lithological character	146
Trap rock	146-147
Fossils, list of	147
Fertilizers	187
Limestone	217
Iron ores, with analyses	225-228
Coal	294-296
Sandstone	304
Millstone	305

KERR, W. C. **1875a.**

Observations on the Mesozoic of North Carolina.

In Am. Assoc. Adv. Sci., Proc., vol. 23, section B, pp. 47-49.

Contains general consideration relating to the dip, geographical distribution, trap, and organic remains of the Newark system. A former great extent of these rocks is inferred.

KERR, W. C. **1879.**

Physiographical description of North Carolina.

Raleigh, N. C. Pp. 1-32, and map.

Contains a very brief description of the extent of the Newark system in North Carolina, p. 11, and of the thickness and character of the coal seams occurring in it, p. 13.

KERR, W. C. **1879a.**

[Geological formations at railroad stations in North Carolina.]

In an American geological railway guide, by James Macfarlane, p. 186.

Indicates what stations in North Carolina are on the Newark system.

KERR, W. C. **1881.**

The minerals and mineral localities of North Carolina. Being chapter 1 of the second volume of the geology of North Carolina.

See Genth and Kerr, 1881.

KERR, W. C. **1884.**

Report on the cotton production of the state of Virginia [etc.].

Washington (Interior Dep., Census Office), 4to, vol. 6, part 2, pp. 617-652. [Tenth Census.]

Contains a very brief description of the Newark areas of Virginia, with some mention of their soils, pp. 630, 631.

KERR [W. C.]. Cited on anticlinal structure of the two Newark areas in North Carolina (W. M. Davis, '86, p. 348).
Cited on the cause of the tilting of the Newark (W. M. Davis, '83, p. 303).
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Cited on the origin and deposition of Newark strata (W. M. Davis, '83, p. 287).
Cited on the tilting of sandstone and trap in South Carolina (W. M. Davis, '83, p. 302).
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Discussion of the hypothesis by. explaining opposing dips (W. M. Davis, '82*a*, p. 119).
Newark sandstone from North Carolina collected by (Shaler, '84, p. 181).
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Ketch's mills, East Windsor, Conn. Fossil bones found at (E. Hitchcock, '41, pp. 503-504, pl. 49).

Kidd's mill, Pa. Dolerite and sandstone from (C. E. Hall, '78, p. 47).

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Limestone near (Dawson and Harrington, '71, p. 34).

KILLEBREW, J. B. 1887.
The elementary geology of Tennessee; being also an introduction to geology in general. Designed for the schools of Tennessee.
See Safford and Killebrew, 1887.

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Kimberton, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).

King of Prussia, Pa. Boundary of the Newark near (C. E. Hall, '81, pp. 22, 83-84).
Brief account of trap dike near (H. D. Rogers, '58, vol. 1, p. 214).

King iron mine, Pa. Analysis of ore from (d'Invilliers, '86, p. 1513).
Report on (Frazer, '77, pp. 212-214).

Kings, Va. Boundaries of the Newark near (W. B. Rogers, '39, p. 76).

Kings county, N. S. General account of the Newark rocks of (Honeyman, '78, pp. 27-28).

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Description of structure at (Darton, '83*a*).
Exposures of trap at (Russell, '80, p. 38).
Faults in trap ridge near (Darton, '90, p. 42).
Small trap sheets near (Darton, '90, p. 39).
Unconformity of trap and sandstone near (Darton, '90, p. 47).

Kingston, N. J. Account of contact metamorphism near (H. D. Rogers, 36, pp. 163-164).
Analysis of soil from (Cook, '78, pp. 37, 39).

Kingston, N. J.—Continued.
Boundaries of Newark system near (Cook, '89, p. 11; H. D. Rogers, '40, p. 118).
Brief reference to trap hills near (H. D. Rogers, 36, p. 159).
Description of quarries at (Cook, '81, p. 55).
Description of sandstone strata near (H. D. Rogers, '40, p. 126).
Description of trap and altered shale near (H. D. Rogers, '40, pp. 149, 151).
Dip in sandstone near (Cook, '82, p. 25).
Dip near (Cook, '68, p. 196).
Quarry at (Cook, '81, p. 55).
Sandstone outcrop near (H. D. Rogers, '40, p. 121).
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Kinsey mountain, Pa. Dip of strata and exposure of trap near (d'Invilliers, '83, pp. 218, 219, 220).

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KIRKBY, J. W. Cited in reference to fossils of the Newark system (Newberry, '88, pp. 68-69).

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Report on the north division of the state [of New Jersey].
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Evidence of faulting near (Nason, '89, p. 33).
Fossil crustaceans found near (Nason, '89, p. 30).

Knauerton, Pa. Boundary of Newark near (Lesley, '83, pp. 185, 191).
Recomposed rocks near (Frazer, '83, p. 235).

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Kralltown, Pa. Catalogue of specimens of sandstone, etc., from near (Frazer, '77, pp. 332-381).
Dolerite from (C. E. Hall, '78, p. 47).
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Kuntz's paint mine, Pa. Report on (Frazer, '77, p. 225).

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Lackalong creek, N. J. Dip along (Cook, '68, p. 197).
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Ladentown, N. Y. Relation of trap and sandstone near (Darton, '90, p. 41).
Section of trap sheet near (Darton, '90, p. 41).

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Relation of trap and sandstone near (Whelpley, '45, p. 63).

Lambertville, N. J. Altered shale near (Cook, '68, p. 213. Cook, '83, p. 23).
Bearing of joints at (Cook, '68, p. 201).
Boundary of trap near (Cook, '68, p. 192).
Brief remarks on banded diorite from (T. S. Hunt, '74).
Building stone near (Cook, '68, p. 511).
Contact metamorphism at (Cook, '82, p. 61. Cook, '87, p. 125).
Contact metamorphism near (H. D. Rogers, '36, pp. 161-162).
Course of trap ridge near (Nason, '89, p. 35).
Description of geology near (W. M. Davis, '83, pp. 278-279).
Description of quarries near (Cook, '81, p. 59).
Description of Sourland mountain, near (Cook, '68, pp. 191-192).
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Dip in red shale at (Cook, '82, p. 26).
Dip near (Cook, '68, p. 197. Cook, '68, p. 198).
Dip of altered shale at (Cook, '79, p. 29. Cook, '82, p. 26).
Diverse dips near (Nason, '89, p. 19).
Fault near (Lesley, '83, p. 181).
Limestone near (Cook, '68, p. 215. Cook, '79, p. 32).
Quarries at (Cook, '81, p. 59).
Quarries of trap rock at, mention of (G. P. Merrill, '89, p. 436).
Section near, after G. H. Cook (W. M. Davis, '83, p. 281, pl. 9).
Shale and sandstone quarries (Cook, '79, p. 24).
Silurian limestone in Newark rocks near (Cook, '83, p. 26).
Trap hill near (Nason, '89, p. 36).
Trap outcrop near (Cook, '68, p. 192. Darton, '90, p. 69).
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Lamentation mountain, Conn. Anterior trap ridges of (Davis and Whittle. '89, pp. 108-109).
Bed of volcanic ash in (Chapin, '89. Chapin, '91).
In the anterior ridge of (Davis and Whittle, '89, pp. 118-120).

Lamentation mountain, Conn.—Continued.
Description of the main ridge of (Davis and Whittle, '89, p. 112).
Description of trap ridges near (Percival, '42, pp. 351, 356-358).
Detailed study of the structure of (W. M. Davis, '89, pp. 61-64).
Discussion of the origin of (W. M. Davis, '89*b*, p. 25).
Discussion of the structure of (W. M. Davis, '86).
Faults associated with (W. M. Davis, '82).
Fault near (Davis, '82, p. 122. W. M. Davis, '88, p. 469).
Limestone near (Percival, '42, p. 443).
Overflow, origin of (W. M. Davis, '82. W. M. Davis, '88, pp. 464-467).
Sandstone elevations associated with (Percival, '42, p. 435).
Small map of north end of (Davis and Whittle, '89, pl. 3).
Small map of portion of (Davis and Whittle-89, pl. 2).
Sketch map of (W. M. Davis, '89, pls. 1, 3).
Stratified rocks associated with (Percival, '42, p. 433).
Topographic form of trap ridge near (Percival, '42, p. 304).
Trap ridges near (Percival, '42, pp. 348-377).
View of, to illustrate structure (W. M. Davis, 89*c*, p. 426).

Lamington, N. J. Section of sandstone at (Darton, '90, p. 35).

Lancaster, S. C. Description of trap dikes near (Tuomey, '44, p. 12).

Lancaster county, Pa. Brief report on (Lesley, '85, pp. lxiv-lxv, pl. 35).
Geological map of (Frazer, '80).
Report on the geology of (Frazer, '80).

Landis iron mine, Pa. Description of (d'Invilliers, '86, pp. 1513-1514).
Report on (Frazer, '77, pp. 220-221).

Large curtain, P. E. I. Section at (Dawson and Harrington, '71, p. 20).

Latschaw iron mine, Pa. Faulted sandstone near (H. D. Rogers, '58, vol. 1, p. 89).

Lawrence brook, N. J. Altered shale near (Cook, '68, pp. 213-214).
Boundary of Newark along (Cook, '68, p. 175).
Detailed description of (Darton, '90, pp. 59-61).
Dip along (Cook, '68, p. 196).
Dip in shale at (Cook, '82, p. 25).
Origin of trap near (Darton, '89, p. 138).
Position of trap near, in the Newark system (Darton, '89, p. 139).
Sandstone quarries near (Cook, '79, p. 23).
Trap hills near (Cook, '68, pp. 189, 190).
Trap outcrops near (Cook, '82, p. 59-60).

Lawrys island, Pa. Description of trap dike near (H. D. Rogers, '58, vol. 2, p. 686).

LEA, ISAAC A. **1851.**
[On the finding of fossil reptilian bones in a calcareous conglomerate near upper Milford, Lehigh county, Pa.]

LEA, ISAAC A.—Continued.

In Philadelphia Acad. Nat. Sci., Proc., vol. 5, 1852, pp. 171–172, 205.

Describes the position and character of the beds in which the fossil bones were found, and discusses the relation of the strata to outcrop of calcareous conglomerate found elsewhere in the Newark system, pp. 171–172. Remarks continued on p. 205, where the name *Clepsysaurus pennsylvanicus* for certain fossil bones is proposed.

LEA, ISAAC. **1853.**

Description of a fossil saurian of the New Red sandstone formation of Pennsylvania; with some account of that formation.

In Philadelphia Acad. Nat. Sci., Jour., 2d ser., vol. 2, 1850–1854, pp. 185–202, pl. 17–19.

Abstract in Am. Jour. Sci., 2d ser., vol. 14, p. 451.

Presents a critical review of the works of previous writers on the paleontology and the geological position of the Newark system, followed by a description of a genus of fossil saurians, based on certain fossil bones found in upper Milford, Lehigh county, Pa.

LEA, ISAAC. **1855.**

[Note on the tracks of crustaceans and other markings on the sandstone of Connecticut valley.]

In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 276–277.

An extract from a letter referring to a slab of sandstone from Greenfield, Mass.

LEA, ISAAC. **1856.**

Remarks on a tooth of a sauroid reptile, from near Phœnixville [Pa.].

In Philadelphia Acad. Nat. Sci., Proc., vol. 8, 1856, pp. 77–78.

Abstract in Am. Jour. Sci., 2d ser., vol. 22, pp. 122–123; also Neues Jahrbuch, 1857, p. 253.

Describes the tooth of a reptile to which a name is given. Names also two species of Posidonia, and a fossil footprint from the locality that yielded the reptilian remains.

LEA, ISAAC. **1857.**

[Remarks on fossils from Phœnixville, Pa.]

In Philadelphia Acad. Nat. Sci., Proc., vol. 9, 1858, p. 149.

Brief abstract of remarks on a fossil bone and a coprolite from the tunnel at Phœnixville, Pa.

LEA, ISAAC. **1857a.**

[Brief remarks on the identity of the rocks near Gwynned, Pa., with those at Phœnixville, Pa.]

In Philadelphia Acad. Sci., Proc., vol. 9, 1858, p. 173.

Brief record of remarks based on fossils from the localities named.

LEA [ISAAC]. **1858.**

[Remarks on the age of the Newark system.]

In Philadelphia Acad. Nat. Sci., Proc., vol. 10, pp. 90–92.

LEA, I[SAAC]—Continued.

A brief statement of the opinions and conclusions of various geologists concerning the geological position of the Newark system.

LEA [I.]. Cited on the age of the Newark system (Lea, '58).

Cited on the age of the Newer Red sandstone of Prince Edward island (Leidy, '54, p. 330).

Cited on the age of the Red sandstone of Prince Edward island (Owen, '76, p. 361).

Cited on fossil crustaceans from the Newark system (Jones, '62, p. 86).

Cited on fossil plants from Turners Falls, Mass. (Emmons, '57, p. 134).

Cited on fossil reptiles from North Carolina (Emmons, '57, p. 73).

Cited on fossil reptiles from Pennsylvania (Emmons, '56, pp. 298, 308. Frazer, '77*a*, p. 497. H. D. Rogers, '58, vol. 2, p. 692–693).

Cited on fossil reptiles from Pennsylvania and New Jersey (H. D. Rogers, '58, vol. 2, p. 695).

Notice of the description of reptilian fossils by (Miller, '79–'81, vol. 2, p. 152).

Lead, at Berlin, Conn. (E. Hitchcock, '35, p. 232).

In Massachusetts, brief account of (E. Hitchcock, '41, p. 448).

Leakesville, Va. Boundary of the Newark near (W. B. Rogers, '39, p. 75).

Description of geology near (W. B. Rogers, '39, p. 78).

Leaksville, N. C. Analysis of coal from near (Chance, '85, pp. 64–65).

Boundary of the Newark near (Mitchell, '42, p. 134).

Brief account of the rocks near (Emmons, '52, p. 149).

Character and dip of rocks at (Emmons, '56, p. 255).

Coal at (Emmons, '57, p. 33. Kerr, '75, p. 145. Kerr, '75, p. 295. McGehee, '83, p. 77).

Conglomerate near (Emmons, '52, p. 152. Emmons, '56, p. 256).

Dip and strike at (Emmons, '56, pp. 257, 258).

Dip of coal at (McGehee, '83, p. 77).

General section of Newark rocks near (Jones, '62, p. 89).

Newark system near (Macfarlane, '77, p. 527).

Reference to fossil fishes from (E. Hitchcock, '41, p. 440).

Reptile remains from (Emmons, '56, p. 309. Emmons, '57, p. 81).

Section near (Emmons, '52, p. 149. Emmons, '56, p. 257).

Thickness of coal seams near (Chance, '85, p. 64).

Thickness of sandstone at (Emmons, '57, p. 22).

Lebanon, N. J. Analysis of trap near (Cook, '68, p. 218).

Boundaries of the Newark system near (Cook, '89, p. 11. H. D. Rogers, '40, p. 16. H. D Rogers, '40, p. 118).

Boundary of trap near (Cook, '68, p. 193).

Lebanon, N. J.—Continued.
Conglomerate at (Cook, '65, p. 7. Cook, '68, p. 210. Cook, '82, p. 21. Cook, '82, p. 41).
Conglomerate quarries near (Nason, '89, p. 39).
Contact of Newark rocks and gneiss near (H. D. Rogers, '40, p. 16).
Dip in shale and conglomerate near (Cook, '82, p. 28).
Dip near (Cook, '68, pp. 198, 199).
Exposure of trap near (Cook, '82, p. 64).
Small sandstone area near (Cook, '68, p. 75).

Lebanon, Pa. Description of trap dikes near (H. D. Rogers, '58, vol. 2, p. 687).
Detailed description of the Cornwall iron mines (Lesley and d'Invilliers, '85).

Lebanon county, Pa. Brief report on (Lesley, '85, p. lxviii, pl. 22).

Lebanon station, N. J. Boundary of Newark near (Cook, '68, p. 175).
Dip near (Cook, '68, p. 197).

Lebanon valley, Pa. Brownstone quarries in (d'Invilliers, '86, pp. 1562–1567).

Lebanonville, N. J. Boundary of Newark near (Cook, '68, p. 175).
Dip near (Cook, '68, p. 197).

LE CONTE, JOHN. Cited on a fossil insect in the Connecticut river sandstone (J. D. Dana, '62).

LE CONTE, JOSEPH. 1882.
Elements of Geology.
New York, revised and enlarged edition, pp. i–xiv, 1–633, pl. 1, 1st ed. New York, 1878, pp. i–xiii, 1–588, pl. 1.
Contains a condensed résumé concerning the Jura-Trias of North America. Under the name Jura-Trias all rocks of the Triassic and Jurassic are included, pp. 451–470. Note on the former extent of the Newark system, p. 608.

LE CONTE, JOSEPH. 1884.
A compend of geology.
New York, 12mo, pp. 1–399.
Contains a brief compiled account of the Jura-Trias of America, pp. 325–331.

LE CONTE, J. Cited on the cause of the monoclinal structure of certain Newark areas (W. M. Davis, '86, p. 344. W. M. Davis, '83, p. 303).
Cited on the mode of formation of the Newark rocks of New Jersey and the Connecticut valley (Russell, '78, pp. 251–252).
Cited on Mormolucoides articulatus (Scudder, '68, p. 218, Scudder, '84, p. 431).

Leesburg, Pa. Mention of trap quarries at (S. P. Merrill, '89, p. 436).

Leesburg, Va. Boundary of Newark near (Heinrich, '78, p. 235. W. B. Rogers, '40, pp. 61, 63).
Conglomerate near (Fontaine, '79, p. 32. Lea, '53, p. 190).
Detailed description of geology near (W. B. Rogers, '40, p. 66).
Quarries of trap rock near (Shaler, '84, p. 179).

Lehigh county, Pa. Brief notes on (Lesley, '75).
Brief report on (Lesley, '85, pp. lxviii–lxix, pl. 36).
Dip at (C. E. Hall, '83).
Fossil saurian bones in (Lea, '53, pp. 188, 195).
Reptilian bones in (Lea, '51, pp. 171–172).

LEHMAN, A. E. Limestone collected by, in Pennsylvania (Shaler, '84, p. 156).

LEIDY, JOSEPH. 1854.
On Bathygnathus borealis, an extinct saurian of the New Red sandstone of Prince Edward island.
In Philadelphia Acad. Nat Sci., Jour., 2d ser., vol. 2, 1850–1854, pp. 327–330, pl. 33.
Describes Bathygnathus borealis.

LEIDY, JOSEPH. 1854a.
[Remarks on Bathygnathus borealis from near Prince Edward island.]
In Philadelphia Acad. Nat. Sci., Proc., vol. 6, 1852–1853, p. 404; also in Am. Jour. Sci., 2d ser., vol. 6, pp. 444–445.
Abstract in Neues Jahrbuch, 1855, pp. 499–500.
Proposes the name given in the title.

LEIDY, J. 1857.
[Remarks on fossils from Phœnixville, Pennsylvania.]
In Philadelphia Acad. Nat. Sci., Proc., vol. 9, 1858, pp. 149–150.
Compares certain fossils from the locality mentioned with others from Virginia, North Carolina, and England, and suggests the age thus indicated.

LEIDY, J. 1857a.
[Remarks on fossils from the Gwynned tunnel, Pa.]
In Philadelphia Acad. Sci., Proc., vol. 9, 1858, p. 150.
Brief record of remarks on fossils from the localities named.

LEIDY, JOSEPH. 1858.
[Note on fucoids and footprints from the sandstone of the Connecticut valley.]
In Ichnology of New England, by Edward Hitchcock, pp. 165–166.
Extract from a letter referring briefly to certain drawings of fossils supposed to be in part fucoid impressions and in part footprints of crustaceans.

LEIDY, JOSEPH. 1860.
[Remarks on fossils found near Phœnixville, Pa.]
In Philadelphia Acad. Nat. Sci., Proc., vol. 11, 1859, p. 110.
Mentions briefly the fossils obtained at Phœnixville, Pa., including a new genus of reptile.

LEIDY, JOSEPH. 1869.
The extinct mammalian fauna of Dakota and Nebraska [etc., etc.].
In Philadelphia Acad. Nat. Sci., Jour., 2d ser., vol. 7, pp. i–viii, 9–472, pls. 1–30, and a map.
Contains a remark on Dromatherium sylvestre from North Carolina, p. 410.

LEIDY, [JOSEPH]. 1876.

Fish remains of the Mesozoic red shales [of Pennsylvania].

In Philadelphia Acad. Nat. Sci., Proc., vol. 28, p. 81.

Records the finding of obscure fish remains at Yerke's station on the Perkiomen railroad, in Montgomery county, Pa.

EIDY, J. Cited on character of certain footprints from Turners Falls, Mass. (Deane '56).

Cited of fossil reptiles from North Carolina (Emmons, '57, p. 60).

Cited on fossil reptiles from Pennsylvania and North Carolina (H. D. Rogers, '58, vol. 2, p. 695–697).

Notice of the description of reptilian fossils by (Miller, '79–'81, vol. 2, p. 152).

LEITH-ADAMS, A. Cited on Jurassic reptiles from high northern latitudes (Hull, '87, p. 95).

Lemer's ore pit, Pa. Report on (Frazer, '77, p. 225).

Leonia, N. J. Indurated shale near (Darton, '90, p. 52).

Leopard, Pa. Trap dike near (Lewis, '85, p. 444).

Lepreuce, N. B. Age of rocks at (Bailey, '65, p. 5).

LESCHARBOT. Cited on native copper from the bay of Fundy (Gilpin, '77, p. 749).

LESLEY, J. P. 1856.

Manual of coal and its topography. Illustrated by original drawings, chiefly of facts in the geology of the Appalachian region of the United States of North America.

Philadelphia, 12 mo, pp. i–xii, 1–224.

Contains a brief account of the origin of the trap ridges of the Newark system of Pennsylvania and New Jersey, pp. 132–133. Refers to lamination in the trap of East and West Rocks, Conn., p. 162.

LESLEY, J. PETER. 1863.

[On an asphalt vein in West Virginia.]

In Am. Phil. Soc., Proc., vol. 9, pp. 183–197, pl. 3–4.

Contains theoretical consideration respecting the deposition and erosion of the Newark system, pp. 188–189.

LESLEY, J. PETER. 1864.

[On the discovery of lignite in Franklin county, Pa., and its bearing on the determination of the age of the present surface of the land.]

In Am. Phil. Soc., Proc., vol. 9, pp. 463–482, and 4 plates.

Discusses the manner in which the Newark rocks of Pennsylvania were deposited.

LESLEY, J. P. 1873.

[Remarks on iron ores near Doylestown, Pa.]

In Am. Philo. Soc., Proc., vol. 13, p. 264.

[LESLEY, J. PETER]. 1874.

Notes on the geology of Lehigh county, Pa.

In Second Geol. Surv. of Pennsylvania, 1874. Report on the Brown Hematite ore ranges of Lehigh county vol. D, pp. 57–66.

Contains brief observations on the Newark rocks of Lehigh county, pp. 61–64.

LESLEY, J. P. 1880.

Geological map of Cumberland county, Pa.

In Second Geol. Surv. of Pennsylvania, vol. D, 5, atlas. No text accompanying.

LESLEY, JOSEPH PETER. 1888.

The geology of Chester county after the surveys of Henry D. Rogers, Persifor Frazer, and Charles E. Hall.

In second geological survey of Pennsylvania, vol. C, 4, pp. 1–54, 63–214, 351–354, pl. 2.

Unconformity at base of the Newark system with hypothesis to account for it, p. 22. Folding of the Appalachians previous to the Newark, p. 132. A general statement of the character of the Newark of Pennsylvania, compiled principally from reports of previous observers, pp. 178–215.

LESLEY JOSEPH PETER. 1885.

Second geological survey of Pennsylvania. Report of progress.

A geological hand atlas of the sixty-seven counties of Pennsylvania, embodying the the results of the field work of the survey from 1874 to 1884.

Harrisburg, pp. i–cxii, pl. 1–61, and 2 maps.

Presents brief sketches of the geology of each county, in explanation of accompanying maps.

LESLEY, J. PETER. 1886.

Geology of the Pittsburg coal region.

In Am. Inst. Min. Eng., Trans., vol. 14, 1885–1886, pp. 618–656, and on map op, p. 656.

General remarks on the deposition of the Newark rocks of Pennsylvania, p. 630. Area occupied shown on the map op. p. 656.

LESLEY, J. P. 1891.

On an important boring through 2,000 feet of Trias, in eastern Pennsylvania.

In Am. Philo. Soc., Proc., vol. 29, pp. 20–25.

Gives a record of strata passed through in boring a well in Bucks county, 18 miles north of Easton, Pa. In remarks on the paper, B. S. Lyman states the rocks penetrated belong in the central portion of the Newark system, which is 2,100 feet thick.

LESLEY, J. P. Cited on former extent of the Newark system (Macfarlane, '79, p. 41).

Cited on mode of formation of the Richmond coal field, Virginia (Clifford, '87, pp. 6, 29–30).

Cited on overflow trap sheets in Pennsylvania (W. M. Davis, '83, p. 298).

Cited on relation of trap and sandstone in Pennsylvania (W. M. Davis, '83, p. 287).

Cited on structure and mode of formation of the Richmond coal field, Virginia (Macfarlane, '77, pp. 510–514).

LESLEY, J. P., and PERSIFOR FRAZER. 1876.

Geological map of Adams county Pa.

In second geological survey of Pennsylvania, vol. D 5, atlas. No text accompanying.

LESLEY, J. P., and E. V. d'INVILLIERS. 1885.

Report on the Cornwall iron ore mines, Lebanon county, Pa.

LESLEY, J. P., and E. V. d'INVILLIERS—Continued.

In Ann. Rep. of the Geol. Surv. of Pennsylvania for 1885; Harrisburg, Pa., 1886, pp. 491–570, and plates.

Gives a detailed description of the iron ore body at the Cornwall mines, and states its relation to the trap and sedimentary beds of the Newark system. A fault having a throw of several thousand feet is stated to exist at the junction of the Newark rocks with the bordering formations on the west; strikes and dip, character of the trap dike, etc., are given.

LESQUEREUX, L. 1876.

On the tertiary flora of the North American lignitic, considered as evidence of the age of the formation.

In annual report of the United States geological and geographical survey of the Territories, embracing Colorado and parts of adjacent Territories, being a report of progress for the year 1874. By F. V. Hayden. Washington (Interior Dep.), pp. 275–365, pls. 1–8.

Contains a brief reference to the age of the Newark system as indicated by fossil plants.

LESQUEREUX, LEO. 1879.

[A fossil tree trunk found at Belleville, N. J.]

In [Annual report on the geology of New Jersey for 1879], pp. 26–27.

A quotation from a letter in reference to a photograph of a fossil tree trunk supposed to be a Lepidodendron.

Lesser cross roads, N. J. Copper ores near (Cook, '68, p. 678).

Dip in shale near (Cook, '82, p. 29).

Dip near (Cook, '68, p. 198).

Leverett, Mass. Note on conglomerate near (Nash, '27, p. 247).

Stratigraphy in (Walling, '78).

LEWIS, HENRY CARVILL. 1880.

A new locality for lignite.

In Philadelphia Acad. Nat. Sci., Proc., vol. 32, p. 281.

Describes the occurrence of lignite in Montgomery county, Pa., in what the author seems to regard as Newark beds.

LEWIS, HENRY CARVILL. 1880a.

The iron ores and lignite of the Montgomery county valley.

In Philadelphia Acad. Nat. Sci., Proc., vol. 32, pp. 282–291.

Contains a few observations on the Newark system in the region referred to.

LEWIS, HENRY CARVILL. 1880b.

On a new fucoidal plant from the Trias [of New Jersey].

In Philadelphia Acad. Nat. Sci.. Proc., vol. 32, pp. 293–294.

Abstract in Neues Jahrbuch, 1882, p. 138.

Describes and figures the cast of what is described as a fossil fucoid, under the name of *Palæophycus limaciformis*, from Milford, N. J.

LEWIS, H. C. 1882.

On a fault in the Trias near Yardleyville, Pa.

In Philadelphia Acad. Nat. Sci.. Proc., vol. 34, pp. 40–41.

Describes the occurrence of a dike of trap coincident with a fault between sandstone and conglomerate. Refers also to change in the dip of sandstone and shale produced by trap dikes.

LEWIS, H. CARVILL. 1882a.

The geology of Philadelphia.

In Franklin Inst. Journal, 3d ser., vol. 85, 1883 pp. 359–374, 422–427.

Includes a brief popular account of the general features of the Newark system near the locality mentioned, together with a reference to the reptilian fossils found in the same beds, and the mode of origin of the associated trap rock, pp. 426–427.

LEWIS, H. CARVILLE. 1884.

[Note on Newark fossils from near Phœnixville, Pa.]

In Science, vol. 3, p. 295.

States that two species of Unio, together with undetermined marine shells and remains of plants and animal, have been obtained near the town mentioned.

LEWIS, H. CARVILL. 1885.

A great trap dike across southeastern Pennsylvania.

Am. Phil. Soc., Proc., vol. 22, pp. 438–456, map op. p. 440.

Abstract in Science, vol. 4, p. 328; also in Am. Assoc. Adv. Sci., Proc., vol. 33, pp. 402–403, and in Neues Jahrbuch, 1887, p. 74.

Reviewed by Persifor Frazer in Am. Philo. Soc., Proc., vol. 21, pp. 691–694.

Describes in detail the course of a trap dike which enters Pennsylvania at Penmar at the southwest and extends nearly to the Delaware on the east. The course of the dike is shown on the map op. p. 440. The association of the dike with a great fault in Bucks county is discussed.

A criticism of this paper by P. Frazer is replied to, p. 456. For Frazer's rejoinder, see Frazer, 1884.

LEWIS, H. C. Review of a paper by, on a great trap dike across southeastern Pennsylvania (Frazer, '84).

Lewisburg, Pa. Contact metamorphism near (H. D. Rogers, '58, vol. 2, pp. 688–689).

Sandstone from (E. C. Hall, '78, p. 36).

Trap dikes near (H. D. Rogers, '58, vol. 2, p. 688).

Trap hills near (H. D. Rogers, '58, vol. 2, p. 688).

Leyden, Mass. Contact of Newark system and Primary rocks in (E. Hitchcock, '35, p. 223).

Description of the gorge and glen in (E. Hitchcock, '41, pp. 285–286).

Dip and strike at (E. Hitchcock, '41, p. 448).

Dip of sandstone in (E. Hitchcock, '35, p. 223).

Junction of Newark system and Primary rocks in (E. Hitchcock, '41, p. 448).

Liberty center, N. J. Course of trap ridge near (Nason, '89, p. 35).

Liberty corner, N. J. Analysis of trap from near (Cook, '68, p. 218).
Boring for coal at (Cook, '68, p. 696).
Boundary of First mountain trap at (Cook, '68, p. 182).
Copper ores near (Cook, '68, p. 678).
Course of trap ridge near (Cook, '82, p. 56).
Dip in shale near (Cook, '82, p. 29).
Dip near (Cook, '68, p. 198).
Diverse dips near (Nason, '89, p. 18).
Long hill near, described (Cook, '68, p. 187).

Lichti's (or Lighty's) ore bank, Pa. Report on (Frazer, '77, p. 229).

LIEBER, OSCAR MONTGOMERY. **1856.**
[First annual] report on the survey of South Carolina.
Columbia, S. C., pp. i-vii, 1-133, pl. 1-9.
Contains a brief account of the Newark system in South Carolina, pp. 19-20, 103, 106, pl. 6.

Lignite at Martin's head, N. S. (Dawson, '78, p. 99).
Mention of (Bailey, Mathews and Ells, '80, p. 21D).

Lignite from North Carolina and Virginia, age indicated by (W. B. Rogers, '55*a*).

Lily pond, Gill, Mass. Description of fossil footprints from (C. H. Hitchcock, '88, pp. 123-124).

Lime post, Pa. Diverse dips near (Nason, '89, p. 19).

Limestone, bituminous, near Meriden, Conn., mention of (W. M. Davis, '89, p. 62).

Limestone in Connecticut valley (Percival, '42, p. 365).
Brief account of (W. M. Davis, '88, p. 468. Percival, '42, p. 316).
Deposited from springs (Emerson, '87, p. 19).
Description of (Percival, '42, pp. 375, 428, 443-444).
Description of the occurrence of (Percival, '42, pp. 316, 344, 392).
Discussion of the origin of (W. M. Davis, '89, p. 66).
Mention of (W. M. Davis, '89, pp. 64-65.)

Limestone (Potomac marble) in Maryland (Shaler, '84, p. 177. pl. 46).

Limestone in Massachusetts. At West Springfield (E. Hitchcock, '41, p. 659).
Brief account of (E. Hitchcock, '35, pp. 218-219).
Description of (E. Hitchcock, '41, p. 444).
Discovery of (E. Hitchcock, '35, pp. 38-39).
Metamorphosed by heat of trap at West Springfield (E. Hitchcock, '35, p. 425).

Limestone in New Jersey (Britton, '85*a*. Cook, '79, pp. 31, 33. Cook, '82, pp. 42-43).
Analysis of (Cook, '68, p. 516).
Description of (Cook, '68, pp. 214-215. Cook, '82, p. 23).
Localities of, in the Newark system (Nason, '89, p. 22).
Near Clinton valley (Nason, '89, p. 18).

Limestone in New Jersey—Continued.
Near Feltville (Cook, '79, p. 18. Nason, '89, p. 20).
Near Scotch plains (H. D. Rogers, '40, p. 134).

Limestone in New York. Conglomerate of Rockland county, brief account of (Mather, '39, pp. 126-127).
Rockland county, brief account of (Mather, '39, p. 126. Mather, '43, pp. 288-289).

Limestone in North Carolina (Emmons, '57, p. 33).
Chatham county (McLenahan, '52, p. 170).
Dan river coal field (Emmons, '52, p. 154).

Limestone in Nova Scotia (Ells, '84, p. 12E).

Limestone in Pennsylvania. Bucks county, mention of (Lewis, '85, p. 449. Lesley and d'Invilliers, '85).
Near Dillsburg (Frazer, '77, pp. 225, 308).
Analysis of (Frazer, '76*c*, p. 63)
Near Liverpool (Frazer, '76, p. 159).
Quarries of (Shaler, '84, p. 156).
York county, analysis of (McCreath, '81, pp. 79-80).

Limestone in Virginia. Detailed description of (Heinrich, '78, p. 243).

Limestone on Prince Edward island (Dawson and Harrington, '71, pp. 34, 41).

LINCKLAEN, LEDYARD. **1861.**
Guide to the geology of New York and to the state geological cabinet.
In fourteenth annual report of the regents of the university on the state cabinet of natural history.
Albany. Pp. 17-84.
Contains a brief and very general account of the geology of Rockland county, N. Y., pp. 34, 53, 76.

Lincoln university, Pa. Mention of a trap dike near (Frazer, '85, p. 693. Lewis, '85, p. 447).

Linden race track, N. J. Record of bored well at (Nason, '89*b*).

Lindsley's mill, N. J. Dip of building stone near (H. D. Rogers, '40, p. 133).

Linoleumville, N. Y. Description of trap rock at (Britton, '81, p. 169).

Lionville, Pa. Trap dike near (Lewis, '85, p. 445).

Lisburn, Pa. Conglomerate near (H. D. Rogers, '58, vol. 2, pp. 682, 683).
Trap dikes near (H. D. Rogers, '58, vol. 2, pp. 688, 689).
Trap ridge near (H. D. Rogers, '58, vol. 2, p. 678).

Lititz, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).

LITTLE, GEORGE. **1878.**
Catalogue of ores, rocks, and woods selected from the Geological Survey collections of the state of Georgia, U. S. A., with a description of the geological formations.
Atlanta, Ga. Pp. 1-16.
Contains a brief account of trap dikes in Georgia, which are probably a portion of the series of dikes traversing the Newark system.

Little falls, Conn. Fossil fishes at (C. H. S. Davis, '87, p. 21).

Little falls, N. J. Basaltic columns at (Cook, '68, p. 203).
Bearing of joints at (Cook, '68, p. 201).
Boundary of Newark near (Cook, '68, p. 175).
Boundary of Second mountain, trap near (Cook, '68, pp. 183, 184).
Building stone at (Cook, '68, p. 505).
Character of the rocks in quarries near (Nason, '89, p. 23).
Columnar trap at (Cook, '68, p. 203. Cook, '82, p. 53, pl. 5).
Contact of trap and sandstone at (Cook, '83, p. 23).
Description of geology near (W. M. Davis, '83, pp. 272–274).
Description of sandstone near (Cook, '68, p. 209. H. D. Rogers, '40, p. 131).
Description of trap sheet near (Darton, '90, pp. 20, 22).
Description of trap outcrop near (H. D. Rogers, '40, p. 147).
Dip in sandstone at (Cook, '79, p. 30. Cook, '82, p. 24. H. D. Rogers, '40, p. 131).
Dip near (Cook, '68, p. 196).
Erosion of trap rock at (Cook, '82, pp. 15–16).
Gap in Second mountain at (Cook, '82, p. 52).
Lower contact of trap sheet at (Darton, '90, p. 31).
Lowering of trap reef at (Cook, '68, p. 855).
Notch in First mountain near (Nason, '89, p. 26).
Occurrence of fossil plants at (Lea, '53, p. 193).
Plant remains in sandstone near (Nason, '89, pp. 23, 28).
Quarries at (Cook, '79, pp. 20, 22. Cook, '81, pp. 49–51. Shaler, '84, p. 141).
Sandstone beneath trap at (Cook, '68, p. 183).
Section of trap sheet near (Darton, '90, pp. 30, 31).
Succession of trap sheets at (Darton, '90, p. 25).
Thickness of strata at (Cook, '68, p. 201).

Little river valley, N. S. Basaltic trap of (Jackson and Alger, '33, p. 295).

Little round top, Pa. Specimens of trap from (C. E. Hall, '78, p. 27).

Little snake hill, N. J. See Snake hill (Cook, '68, pp. 178–179).

Littlestown, Pa. Altered conglomerate near (H. D. Rogers, '58, vol. 2, p. 680).
Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).
Dip near (Frazer, '76, p. 102).
Dolerite from (Frazer, '76, p. 159).
Dolerite, sandstone, and conglomerate from near (C. E. Hall, '78, p. 23).
Section from, to Gettysburg (Frazer, '77, pp. 299–304, pl. op. p. 304).
Trap dikes near (Frazer, '76, p. 102. H. D. Rogers, '58, vol. 2, p. 680).

Little York, N. J. Boundaries of Newark system near (Cook, '89, p. 11).
Conglomerate at (Cook, '68, p. 210. Cook, '82, p. 41).
Dip in shale near (Cook, '82, p. 27).

Little York, N. J.—Continued.
Gneiss bordering the Newark system near (Nason, '89, p. 16).

Liverpool, Pa. Coal near (Frazer, '85, p. 403).
Limestone and sandstone from near (Frazer, '76, p. 159).
Limestone, coal, etc., from near (C. E. Hall, '78, p. 24).
Remark on coal from (McCreath, '79, p. 103).

Llewellyn Park, N. J. Boundary of First mountain trap near (Cook, '68, p. 181).
Columnar trap at (Darton, '90, p. 24).
Contact of trap and sandstone near (Cook, '82, p. 52).
Description of columnar trap near (Iddings, '86).
Description of sandstone near (Cook, '68, p. 209).
Dip at (Cook, '68, p. 195).
Dip in sandstone near (Cook, '79, p. 30. Cook, '82, p. 24).
Sandstone quarry at (Cook, '79, p. 22).

Lockatong, N. J. Aranaceous strata near (H. D. Rogers, '40, p. 123).

LOCKE, (—). Cited on the magnetism of trap rocks (E. Hitchcock, '45*a*).

Lockhart shoals, S. C. Trap dikes near (Hammond, '84, p. 466).

Lockville, N. C. Brief account of rocks near (Emmons, '57*b*, p. 77).
Fossil plants from (Emmons, '57, pp. 100–132, 145).
Hematite near (Willis, '86, p. 305).

Lockville (Jones's falls), N. C. Plant bed at, with description of fossils (Emmons, '56, pp. 324–327).

LOGAN, W. E. **1865.**
Geological survey of Canada, report of progress from its commencement to 1863. Atlas of maps and sections with an introduction and appendix.
Montreal. Pp. i-vi, 1–42, and 13 plates and maps.
The geological map in this report indicates areas occupied by Newark rocks.

LOGAN, W. E. **1866.**
Geological map of Canada and adjacent regions, including parts of the United States.
Montreal.
See Hall and Logan, 1866.

LOGAN, W. E. Cited on the age of the Newark rocks of Nova Scotia, etc. (Dawson, '78, p. 109).

Logan mine, Pa. Description of (d'Invilliers, '86, pp. 1510–1511).
Report on (Frazer, '77, p. 211).

Logansville, Pa. Trap near (Frazer, '76, p. 95. C. E. Hall, '78, p. 43).

Londonderry, N. S. Contact of Newark and Lower Carboniferous near (Ells, '85, p. 48E).

Long hill, N. J. Analysis of trap from (Cook, '68, p. 217).
Boundary of Long hill trap near (Cook, '68, p. 187).
Boundary of Newark near (Cook, '68, p. 175).

Long hill, N. J.—Continued.
Character of the exposures near (H. D. Rogers, '40, p. 132).
Course of (Cook, '82, p. 19).
Description of (Cook, '68, pp. 186-187. Cook, '82, p. 56).
Dip on the southeast of (H. D. Rogers, '40, p. 132).
Reference to geological features of (H. D. Rogers, '40, p. 133).
Sandstone above trap at (Cook, '68, p. 201).
Section from, to Bound Brook, N. J. (Cook, '68, p. 199 and map in portfolio).
See also Third Watchung mountain.

Long island, Va. Boundary of Newark near (Heinrich, '78, p. 237).

Long island, N. S. Description of (Dawson, '78, p. 97. Gesner, '36, p. 174. Jackson and Alger, '33, pp. 219-220).
Dip of sandstone on (Dawson, '78, p. 91).
Rocks of (Gesner, '36, p. 80).
Section near (Dawson, '47, p. 56).

Longmeadow, Mass. Brief account of building stone found at (E. Hitchcock, '35, p. 46).
Dip and strike of rocks in (E. Hitchcock, '41, p. 448).
Notice of building stone at (E. Hitchcock, '32, pp. 35-36).

Longnecker iron mine, Pa. Description of (d'Invilliers, '86, pp. 1509-1510).

Lontaka trap (ridge), N. J. Description of (Cook, '68, p. 188. Cook, '82, pp. 57-58).

LOPER, S. WARD. **1891.**
Two belts of fossiliferous black shale in the Triassic formation of Connecticut.
See Davis and Loper, 1891.

LOPER, S. W. Reference to fossil fishes in cabinet of (Newberry, '88).

Loudoun county, Va. Description of the Newark in (W. B. Rogers, '40, pp. 64-69).

LOUGHRIDGE, R. H. **1884.**
Report on the cotton production of the state of Georgia [etc.].
In Tenth Census of the United States, Washington (Interior Dept., Census Office), 4to, vol. 6, part 2, pp. 259-450).
States that the Newark system is probably represented in Georgia by trap dikes and by clay slates adjacent to the metamorphic region, p. 279.

Lower Montville, N. J. Course of trap ridge near (Cook, '82, pp. 54-55).

Lower Oxford, Pa. Mention of a trap dike in (Frazer, '84, p. 693).

Low torne, N. Y. Elevation and character of (Darton, '90, p. 38).

LYELL, CHARLES. **1842.**
On the fossil footprints of birds and impressions of raindrops in the valley of the Connecticut.
In London Geol. Soc., Proc., vol. 3, 1838-1842, pp. 795-796.
Republished in Am. Jour. Sci., vol. 45, 1843, pp. 394-397.

LYELL, CHARLES—Continued.
Describes the sandstone formation of the Connecticut valley and New Jersey, with its fossil tracks and other impressions. Considers the conditions of its deposition, relation to the hypogene rocks, age, etc.

LYELL [CHARLES]. **1842a.**
[Remarks on the cause of the prevailing dip of the New Red sandstone of the Connecticut valley and of New Jersey and Pennsylvania.]
In Am. Jour. Sci., vol. 43, pp. 170, 172; also in Am. Assoc. Geol. and Nat., Proc., pp. 63, 64, 66.
Brief remarks on a paper by Edward Hitchcock.

LYELL, CHARLES. **1843.**
Fossil footprints.
In lectures on geology, delivered at the Broadway tabernacle, in the city of New York. Lecture VI, pp. 37-43.
Contains a brief account of fossil footprints, fossil fishes, etc., from New Jersey and the Connecticut valley.

LYELL, CHARLES. **1845.**
Travels in North America, with geological observations on the United States, Canada, and Nova Scotia.
London, 12mo, vol. 1, pp. i-xii, 1-316, pl. 1, 3-5, vol. 2, pp. i-viii, 1-272, pl. 2, 6-7.
Another edition of this work was issued in New York, 1845, in two volumes, 12mo, but without a number of the plates that accompany the edition mentioned above. A second English edition appeared in 1855. A German edition translated by Emil Th. Wolff, was published at Halle in 1846.
Reviewed in Quart. Jour. Geol. Soc., London, vol. 1, pp. 389-399, and by E. Emmons in Am. Quart. Jour. Agri. and Sci., vol. 2, pp. 265-267.
Refers briefly to the sandstone and trap near New Haven, Conn., vol. 1, p. 13, and to the same formation in New Jersey, p. 15. Describes also a visit to the Connecticut valley in Massachusetts, in company with E. Hitchcockpp, . 251-255. Mentions the occurrence of sandstone, trap, etc., at cape Blomidon, N. S., vol. 2, pp. 271-272. A colored geological map of the eastern portion of the United States forms the frontispiece of vol. 2. A geological sketch map of the United States forming plate op. p. 75, in vol. 1 of the New York edition, does not appear in the London edition. Mentions also the occurrence of sandstone, trap, amygdaloid, etc., at cape Blomidon, N. S., vol. 2, p. 271.

LYELL, CHARLES. **1847.**
On the structure and probable age of the coal field of the James River, near Richmond, Va.
In Quart. Jour. Geol. Soc., London, vol. 3, pp. 261-280, pls. 8-9.

LYELL, CHARLES—Continued.

Abstract in Am. Jour. Sci., 2d ser., vol. 4, pp. 113-115.

Geological structure of the coal field, p. 261. Vertical calamites, p. 262. Thickness of coal, p. 263. Section showing the geological position of the coal-bearing rocks, p. 263. Section of Midlothian coal mine, p. 265. Junction of coal and granite in Blackheath mines, p. 266. Organic structure and mineral composition of the coal, p. 268. Vegetable structure of mineral charcoal from Clover hill mines, p. 268. Analyses of coals and coke, p. 270. Beds of coal changed to coke by the action of trap, p. 270. Natural coke, p. 272. Position of the trap, p. 273. Age of the coals as determined by organic remains, p. 274. Fossil shells, p. 274. Fossil fishes, p. 275. Whether the strata are of marine or fresh-water origin, p. 278. Fossil plants, p. 278. The coal measures probably of the age of the inferior Oölitic and Lias, p. 279.

LYELL, CHARLES. 1849.

A second visit to the United States of North America.

London, 1849, vol. 1, pp. i-xii, 1-368; vol. 2, pp. i-xii, 1-385.

Second ed. not seen.

Third ed, London, 1855, in two volumes, paged as in 1st ed. Contains an account of a visit to the Richmond coal field, Virginia, vol. 1, pp. 279-288.

LYELL, CHARLES. 1851.

On fossil rain marks of the Recent, Triassic, and Carboniferous periods.

In Quart. Jour. Geol. Soc., London, vol. 7, pp. 238-247.

Describes raindrop impressions from Newark and Pompton, N. J. Gives figures of raindrop impressions and of hail impressions from Pompton, copied from C. W. Redfield, pp. 238, 242-244.

LYELL, C. 1851a.

On the discovery of some fossil reptilian remains and landshells in the interior of an erect fossil tree in the coal measures of Nova Scotia, with remarks on the origin of coal fields and the time required for their formation.

In Roy. Inst. [London], Proc., vol. 1, pp. 281-288.

Gives a brief account of the area, remarks the absence of reptilian remains in, p. 283.

LYELL, CHARLES. 1851b.

[Origin of raindrop impressions.]

In Am. Assoc. Adv. Sci., Proc., vol. 5, p. 74.

Quotation from a letter in a paper by W. C. Redfield.

LYELL, C. 1851c.

On impressions of raindrops in ancient and modern strata.

Royal Inst. [of Great Britain]. Proc., vol. 1, pp. 50-53.

Mentions raindrop impressions from New Jersey.

LYELL, CHARLES. 1852.

Inferences deducible from the raindrop impressions in the Triassic and Carboniferous rocks.

In Ann. Sci. Discov., p. 261.

Brief extract from a lecture in which the impressions of raindrops and associated impressions on certain rocks are interpreted.

LYELL, CHARLES. 1854.

Special reports on the geological, topographical, and hydrographical departments of the exhibition.

In general report of the British commissioners of the New York industrial exhibition in 1853, London, 4to, pp. 1-50.

Abstract in France, Geol. Soc., Bull., 2d ser., vol. 12, part 1, pp. 400-428.

Describes briefly the rocks of the Deep river basin, N. C., and of the Chesterfield basin (Richmond coal field), Va., referring to them as Oolite or Lias. The extent and characteristics of the Newark system in Massachusetts, Connecticut, New Jersey, and Pennsylvania, also receives attention, with special reference to their economic products. The character of the trap rocks in these states and their relation to associated stratified rocks is also treated.

LYELL, C. 1857.

[Remarks on the age of the Richmond coal field, Va.]

In geology of North America, by Jules Marcou, Zurich, 1858, 4to, p. 16.

In a letter to C. Marcou, states that C. Bunbury has changed his statement as to the age of the plants of the Richmond coal field, on account of a change in the determination of the age of the beds with which they were compared.

LYELL, CHARLES. 1866.

Elements of Geology.

New York, 6th ed., pp. i-xvi, 1-803.

Published previously as "A manual of elementary geology," several editions.

Contains a condensed description of the Richmond coal field, Va., the Deep river coal field, N. C., and of the sandstone, etc., of the Connecticut valley.

LYELL, C. 1871.

The Student's Elements of Geology.

London, 12mo, pp. i-xix, 1-624.

Contents relating to the Newark sandstone of the Connecticut valley, p. 361.

Coal field of Richmond, Va., p. 362. Mammalian remains, p. 364. Low grade of early mammals favorable to the theory of progressive development, p. 364.

LYELL, C. Cited on age of certain rocks in Nova Scotia (Dawson, '78, p. 109).

Cited on age of Newark system (Dewey, '57. Lea, '58. Newberry, '88, p. 10).

Cited on age of the Newark system of Virginia (Horner, '46).

Cited on age of the Richmond coal field, Va. (Hull, '81, p. 460. Marcou, '49, pp. 273-274.

LYELL, C.—Continued.

Marcou, '58, p. 16. W. C. Redfield, '56, pp. 185, 187).

Cited on coal mining in the Richmond coal field (Fontaine, '79, pp. 35, 36).

Cited on fossil crustaceans from the Newark system (Jones, '62, pp. 85, 86).

Cited on the fossil fishes of the Newark system (Newberry, '88, p. 20).

Cited on fossil footprints (Murchison, '43).

Cited on the fossil plants of the Richmond area (De La Beche, '48. Fontaine, '83, p. 25).

Cited on geology of the Richmond coal, Virginia (Greer, '71. Taylor, '48, p. 47).

Cited on intrusive trap sheets in Virginia (W. M. Davis, '83, p. 294).

Cited on natural coke in Richmond coal field, Va. (Clifford, '87, p. 12. De La Beche, '48).

Cited on Newark flora (Marcou, '90).

Cited on origin of certain raindrop impressions found in New Jersey (W. C. Redfield, '51*a*, pp. 73, 74).

Cited on Posidonia from the Richmond coal field, Va. (Lea, '56, p. 78).

Cited on relation of trap and sandstone in Massachusetts (Davis, '83, p. 285).

Cited on Richmond coal field, Va. (Clifford, '87, pp. 2, 5, 7, 8, 13, 14, 23, 24).

Cited on Richmond coal field (Clifford, '88. Emmons, '57, pp. 11-13).

Cited on section in the Richmond coal field, Va. (Emmons, '56, p. 339).

Cited on trap dikes in the Richmond coal field, Va. (W. M. Davis, '83, p. 293).

Fossil fishes obtained by, from Connecticut (Egerton, '49, p. 8).

Notice of work by, in Virginia (Miller '79-'81, vol. 2, pp. 149-151).

LYMAN, B. S. 1891.

[Remarks on bored well in Bucks county, near Easton, Pa.]

In Am. Philo. Soc. Proc., vol. 29, pp. 24, 25).

[Remarks on paper by J. P. Lesley. See Lesley, '91, in which the section passed through by the boring referred to is given.]

Lynchburg, Va. Brief account of sandstone near (W. B. Rogers, '36, p. 82).

MACFARLANE, JAMES. 1877.

The coal regions of America; their topography, geology, and development.

New York, 3d ed., pp. i-xvi, 1-696, and 29 maps.

2d ed., New York. Not seen.

1st ed., New York. 1873, pp. i-xvi, 1-676, and 25 maps.

Contains a general account of the Richmond, Va., Deep river and Dan river, N. C., coal fields. Compiled principally from the report of E. Emmons, H. D. Rogers, and J. P. Lesley. Contains geological sketch map of the United States, pl. op. p. 3; a geological map of Pennsylvania, frontispiece; and a map of the United States showing distribution of coal fields, pl. op. p. 626.

MACFARLANE, JAMES. 1879.

An American geological railway guide.

New York, pp. 1-216 and a geological map.

Contains a brief sketch of the Newark system, and indicates what railroad stations are situated on it.

MACFARLANE, JAMES. 1885.

An American geological railway guide. [Being advance sheets of a second edition, relating to the Dominion of Canada.]

New York, pp. 52-82.

Refers briefly to the Newark rocks of Nova Scotia, p. 56.

MACFARLANE, J. Cited on the coal production of the Richmond coal field, Va. (Heinrich, '78, p. 268).

Cited on the value of the Richmond coal field, Va (Hotchkiss, '80, pp. 91-92).

MACKIE, S. J. 1863.

The aeronauts of the Solenhofen age.

In The Geologist, vol. 6, pp. 1-8, pl. 1.

Refers briefly to the footprints of the Connecticut valley.

MACKIE, S. J. 1864.

Fossil birds.

In The Geologist, vol. 6, 1863, pp. 415-424, 445-455, pls. 22-24; vol. 7, 1864, pp. 11-24, 50-53, pls. 1-4.

Contains a brief account of the finding of fossil footprints in the Connecticut valley, followed by a "bibliography of Connecticut footprints," compiled principally from a similar list by Hitchcock in his Ichnology of New England. An extract is also given from Emmons's "American Geology" concerning a fossil bird bone from the Newark rocks of North Carolina.

MACLURE, WILLIAM. 1809.

Observations on the geology of the United States, explanatory of a geological map.

In Am. Phil. Soc., Trans., vol. 6, 1809, pt. 2, pp. 411-428. Republished in same, n. s., vol, 1, 1818, pp. 1 91, pls. 1-2; also as a separate volume, Philadelphia, 1817, 8vo, pp. i-ix, 10-130, pls. 1-2, and map. The map (as stated by Marcou) was reproduced in 1822 by P. Cleaveland as a frontispiece of an elementary treatise on mineralogy and geology, 2d ed., Boston, and also in 1843, in The Geologist.

Portions of the Newark rocks of New Jersey, Connecticut, etc., are considered in connection with other rocks west of the Appalachians, which are now known to be of much older date, under the head of "Secondary formation," and are so represented on the map.

MACLURE (—). Cited on the age of the coal fields of North Carolina (Emmons, '56, p. 271).

MACLURE [W.]. Cited on the age of the Newark system (Lea, '53, pp. 188, 189. Newberry, '88, p. 8. H. D. Rogers, '44, pp. 248, 251. H. D. Rogers, '58, vol. 2, p. 693).

Cited on the age of the Richmond coal field, Va. (Taylor, '35, p. 294).

McCara's Brook, N. S. Trap of (Dawson, '78, p. 316).

M'CLURE, WM. **1822.**
Comparative features of American and European geology.
In Am. Jour. Sci., vol. 5, pp. 197-198.
An extract from a letter relating to the extent and general character of the trap rocks of the Atlantic slope. The former connection of several of the Newark areas between the Connecticut and the Rappahannock is suggested.

M'CLURE, W. Cited on the extent of the Dan river area, N. C. (Olmsted, '27, p. 128).
Cited on the former extent of the Newark system (Olmsted, '24, p. 18).
Cited on the Newark of North Carolina (Olmsted, '20).

McClure iron mine, Pa. Analysis of ore from (d'Invilliers, '86, p. 1513).

McCormick iron mine, near Dillsburg, Pa. Brief account of (Frazer, '76*d*).
Description of (d'Invilliers, '86, pp. 1511-1512).
Report on (Frazer. '77, pp. 214-217, 228-229).

McCREATH, ANDREW S. **1879.**
Second geological survey of Pennsylvania, 1876-1878, MM. Second report of progress in the laboratory of the survey at Harrisburg.
Harrisburg, pp. i-xii, 1-438, and 2 plates.
Contains an analysis of coal from York co., Pa.

McCREATH, ANDREW S. **1881.**
Second geological survey of Pennsylvania, 1879-1880. M3. Third report of progress in the laboratory of the survey at Harrisburg.
Harrisburg, pp. i-xx, 1-126, map in pocket.
Contains analyses of limestones from near Dillsburg, York county, Pa.

McCREATH, A. S. Analysis of coal from the Richmond coal field, Va. (Clifford, '87, p. 10).
Analysis of iron ore from Pennsylvania by (d'Invilliers, '86, p. 1507).
Analysis of iron ores (d'Invilliers, '83, pp. 324, 325, 331-333, 341).
Cited on the composition of coal from the Richmond coal field, Va. (Chance, '85, p. 19).

McGEE, W. J. **1884.**
Map of the United States, exhibiting the present status of knowledge relating to the areal distribution of geologic groups.
In U. S. Geol. Surv., fifth annual report, 1883-1884, pl. 2, in pocket at end of volume.
A compiled map showing areas occupied by the Newark system.

McGEE, W. J. **1888.**
Three formations of the middle Atlantic slope.
In Am. Jour. Sci., 3d ser., vol. 35, pp. 120-143, 228, 330, 367-388, 448-466, pl. 2, 6-7. Reviewed in Am. Geol., vol. 2, pp. 129-131.
States that the Potomac formation rests unconformably on the eroded surface of the Newark, pp. 134, 135.

McGEHEE, M. **1883.**
Handbook of the State of North Carolina, exhibiting its resources and industries.
Raleigh, pp. i-vi, 1-154.
Contains a brief account of the Deep river and Dan river coal fields, pp. 24-25, 75-77, 82.

McKAY, A. W. **1866.**
The red sandstone of Nova Scotia.
British Assoc. Adv. Sci., Rep., No. 35.
A brief summary of facts and conclusions concerning the distribution, lithological character, fossils, geological age, etc., of the Newark rocks of Nova Scotia, pp. 66-67.

McKay's head, N. S. Rocks of (Gesner, '36, p. 254).

McKnightstown, Pa. Sandstone, conglomerate, etc., from (C. E. Hall, '78, p. 42).

McLENAHAN, S. **1852.**
[Observations and remarks on the Deep and Dan river coal fields, North Carolina.]
In report of Professor Emmons, on his geological survey of North Carolina (Executive document, No. 13).
Raleigh, 1852, pp. 168-173.
Describes briefly some of the local features of the coal fields mentioned, pp. 168-171.

Madison, N. C. Brief account of coal near (McGehee, '83, p. 76).
Coal near (Kerr, '75, p. 145).
Conglomerate near (Emmons, '52, p. 152).
Fossil tree-trunks found at (Emmons, '52, p. 148).
Section near (Emmons, '56, p. 259).
Sections with dips and strikes at (Emmons, '52, p. 151).
Thickness of sandstone at (Emmons, '57, p. 22).

Madison, N. J. Dip of sandstone near (H. D. Rogers, '40, p. 133).

Madisonville, N. J. Dip in shale at (Cook, '82, p. 30).

Magdalen islands. Mention of Newark rocks in (Marcou, '58, pp. 11, 65).
Possible Trias on (Richardson, '81, p. 8G).

MAHAN, D. H. **1871.**
[Trap rock as a building stone.]
In an elementary course of civil engineering, New York, p. 3.
Refers to the uses of the trap rock of the Palisades of New Jersey, and mentions its mineralogical composition (criticized by G. P. Merrill, see Merrill, '89, p. 435). Refers also to the sandstone of the Newark, pp. 4-5.

MAHAN [D. H.]. Cited on the mineralogical composition of trap rock (G. P. Merrill, '89, p. 435).

Maidenhead coal mine, Va. Account of (Wooldridge, '42, pp. 2-3).
Analysis of coal from (Clemson, '35. Clifford, '87, p. 10. Macfarlane, '77, p. 515. Williams, '83, p. 82).
Brief account of (Macfarlane, '77, p. 507).
Depth of (Taylor, '48, p. 49).
Explosion in (Taylor, '48, p. 49).

Maidenhead coal mine, Va.—Continued.
Notes on (Taylor, '35, pp. 284, 285).
Thickness of coal in (Taylor, '35, p. 282).

Makefield township, Pa. Report on the geology of (C. E. Hall, '81, pp. 49, 50).

Malvern, Pa. Trap dike near (Lewis, '85, p. 445).

Malvern square, N. S. Minerals near (Willimott, '84, p. 265L).

Mammals, fossil. Brief account of, in reference to age (Emmons, '57*b*, p. 78).
Discussion of (Marsh, '87, p. 344).
From Egypt, redescription of (Osborn, '86).
From North Carolina (Emmons, '57, pp. 93–96).
New genus of (Osborn, '86*a*).
Summary concerning (Miller, '79–'81, vol. 2, p. 244).

Manakin, Va. Coal mines near (Fontaine, '83, p. 3).
Fossil plants from (Fontaine, '83).

Manakin town ferry, Va. Boundary of Newark area near (Heinrich, '78, p. 231).

Manassa, Va. Brief account of sandstone quarries at (G. P. Merrill, '89, p. 461).
Quarries of Newark sandstone at (Shaler, '84, p. 179).

Manassa gap, Va. Boundary of Newark near (Heinrich, '78, p. 235).

Manatawny, Pa. Contact metamorphism at (d'Invilliers, '83, p. 199).

Manchester, Conn. Description of fossil bones from (Marsh, '89, pp. 331–332).
Description of trap dikes in primary rocks near (Percival, '42, pp. 425–426).

Manchester, N. J. Boundary of First mountain trap near (Cook, '68, p. 181).

Manganese, at Blomidon, N. S. (Gesner, '36, p. 217).
In New Jersey (Cook, '68, p. 224).
In New Jersey, near Clinton (Cook, '65, pp. 7–8. Cook, '68, p. 711).
In Nova Scotia (Gilpin, '85, p. 8).
Near Quaco head, N. B. (Gesner, '40, pp. 17–18).

Manheim, Pa. Boundary of the Newark near (Fraser, '80, pp. 13, 37–38. H. D. Rogers, '58, vol. 2, p. 668).

Manitack mountain, Conn. Building stones near (Percival, '42, p. 439).
Description of elevations near (Percival, '42, p. 440).
Description of trap ridges near (Percival, '42, pp. 389–393).
Sandstone associated with trap near (Percival, '42, p. 440).
Topographic form of trap ridge ending in (Percival, '42, p. 307).

MANTELL, GIDEON ALGERNON. 1843.
[On the footprints in the Connecticut valley sandstone.]
In Am. Jour. Sci., vol. 45, pp. 184–185.
Contains general observations regarding the fossils mentioned.

MANTELL, GIDEON ALGERNON. 1846.
Description of footmarks and other imprints on a slab of New Red sandstone, from Turners Falls, Mass., U. S., collected by Dr. James Deane, of Greenfield, U. S.

MANTELL, GIDEON ALGERNON—Continued.
In London Geol. Soc., Quart. Jour., vol. 2, pp. 38–40; also in London and Edinburgh Philo. Mag., 1843, vol. 23, p. 186.
Abstract in Neues Jahrbuch, 1844, p. 248.
Gives a general description of a small slab of sandstone bearing raindrop impressions and footprints.

Map, geological, of Canada (Selwyn and Dawson, '84, map accompanying).
And adjacent regions, including parts of the United States (Hall and Logan, '66).
Scale 125 miles to 1 inch (Logan, '65, map No. 1).
Of the coal fields of the United States (Hitchcock, '74, pl. 11).

Map, geological, in Connecticut. Adjacent ends of Saltonstall and Totoket mountains, Conn. (Davis and Whittle, '89, pl. 2).
Of Connecticut (Percival, '42).
Chauncey peak (Davis and Whittle, '89, pl. 2).
Farmington mountain, and its anterior ridge (Davis and Whittle, '89, pl. 3).
Farmington river gap, at Tariffville (Davis and Whittle, '89, pl. 3).
Hanging hills (W. M. Davis, '89, pl. 4).
Lamentation and Higby mountains, showing trap ridges and faults (W. M. Davis, '89, pl. 3).
Lamentation mountain (W. M. Davis, '89, pl. 1).
Meriden district (W. M. Davis, '89*c*, p. 434).
Newark area, with trap outcrops (Davis and Whittle, '89, pl. 1).
Newark areas (W. M. Davis, '88, pl. 52).
New Haven region (J. D. Dana, '71, pp. 46–47).
North end of Higby mountain (Davis and Whittle, '89, pl. 2).
North end of Lamentation mountain (Davis and Whittle, '89, pl. 3).
North end of Totoket mountain (Davis and Whittle, '89, pl. 2).
Notch mountain and east ridge of the Hanging hills (Davis and Whittle, '89, pl. 2).
Posterior ridge of Saltonstall mountain (Davis and Whittle, '89, pl. 3).
Rock falls of Aramamit river (Davis and Whittle, '89, pl. 3).
Region about Kensington (Percival, '22, map).
Toket and Pond mountains (W. M. Davis, '88, p. 479).
Trap dikes at Wallingford (W. M. Davis, '83, p. 309, pl. 11).
Trap ridges in Woodbury (W. M. Davis, '88, p. 473).
Trap ridges near South Britain (W. M. Davis, '88, p. 470).
South end of Lamentation mountain (Davis and Whittle, '89, pl. 2).
Trap ridges, after Percival (J. D. Dana, '75, pp. 20, 418).
Trap ridges, main, in the Meriden-New Britain district (W. M. Davis, '89, pl. 5).
Trap ridge near Shuttle meadow reservoir (W. M. Davis, '89, pl. 2).
Trap ridges of the East Haven region (Hovey, '89, pl. 9).

Map, geological, of Connecticut valley (E. Hitchcock, '18. E. Hitchcock, '23, vol. 6, map op. p. 80. E. Hitchcock, '35, pl. 15, in atlas. A. Smith, '32, map op. p. 205).
- After Percival (J. D. Dana, '91*a*).
- Showing footprint localities. Scale, 3½ miles to 1 inch (E. Hitchcock, '58, pl. 2).
- Showing Newark area (W. M. Davis, '89, pl. 1).
- Showing outline of Newark area (J. D. Dana, '75*a*, p. 499).
- Trap ridges (J. D. Dana, '75, p. 418).
- Trap ridges in, after Percival (J. D. Dana, '47, p. 391).
- Trap ridges near New Haven (J. D. Dana, '91).
- Of Georgia. Reference to trap dikes in (T. P. James, '76).
- Of Maryland (Tyson, '60).
- Of Massachusetts (E. Hitchcock, '32, map op. p. 1. E. Hitchcock, '35, pl. 1 in atlas. E. Hitchcock, '41, frontispiece to vol. 1. E. Hitchcock, '44*c*).
  - Newark area, after Hitchcock (Walling, '78, pl. op. p. 192).
  - Lead mines and veins of Hampshire county (Nash, '27).
  - Mount Holyoke and Mount Tom (W. M. Davis, '83, pp. 305–307, pl. 10).
  - Mount Toby (Walling, '78, pl. op. p. 192).
  - Scale, 10 miles to 1 inch (C. H. Hitchcock, '71).
  - Showing direction of the strata (E. Hitchcock, '35, pl. 15 in atlas).
  - Showing strikes, dip, axes of elevation, etc. (E. Hitchcock, '41, pl. 53).
  - Turner's falls (W. M. Davis, '83, pp. 305–307, pl. 10).
- Of New Brunswick (Bailey, '65. Bailey, Mathews and Ells, '80, sheets No. 1, NE., No. 1, SE., No. 1, SW., accompanying.)
  - Grand Manan island (Bailey, '72, op. p. 45).
  - Map No. 1, S. W. geological survey of Canada, Province of New Brunswick (Contains map of Grand Manan island and note on the margin) (Bailey, Mathews and Ells, '80).
  - Scale, 25 miles to 1 inch (Dawson, '78, map 2d and 3d ed.).
  - Showing the location of several small Newark areas (Matthew, '65*a*).
  - St. John county, showing Newark at Quaco Head (Matthew, '63, p. 248).
- Of New Hampshire (C. H. Hitchcock, '77).
- Of New Jersey (Cook, '65, p. 21. Cook, '63, p. 39. Cook, '68, in portfolio. Cook, '79. Cook, '81. Cook, '82. Putnam, '86*b*, pp. 146, 150. H. D. Rogers, '40. Whitfield, '85, at end of volume).
  - Arlington trap (Darton, '90, p. 57).
  - Azoic area, paleozoic formations, etc., of New Jersey (Cook, '68, in portfolio).
  - Cretaceous formation, etc. (Cook, '68, in portfolio).
  - Cushetunk and Round mountains (Darton, '90, p. 63).
  - Delaware river region (Darton, '90, pl. 6).
  - Flemington, showing trap outcrops (Darton, '90, p. 66).

Map, geological, of New Jersey—Continu
  - Lake Passaic, showing trap ridg
    '80, frontispiece).
  - Newark area in (Davis and Wood
    396, 407).
  - New Germantown trap region
    '90, p. 36).
  - Intrusive and extrusive trap she
    ton, '90, pl. 1).
  - New Vernon and Longhill tra
    (Darton, '90, p. 34).
  - New Vernon trap sheet and
    (Darton, '90, pl. 4).
  - Northern part, scale, 2 miles t
    (Cook and Smock, '74).
  - Rocky hill, Ten mile run moun
    (Darton, '90, p. 60).
  - Scale, 6 miles to 1 inch (Coo
    pocket. Cook, '82, in pocket
  - Showing outline of trap ridges a
    age lines (Nason, '89, pl. op.
  - Showing portion of New York-
    area (Cook, '86, map.)
  - Showing the relations of the
    traps (Darton, '90, p. 16).
  - Snake hill trap (Darton, '90, p. 5
  - Trap sheets near Hoboken (Dart
    45).
  - In New York (Putnam, '86*a*).
  - Long and Staten islands, with the
    of New York (Mather, '43, pl
  - New York city and vicinity (D
    tin, '88).
  - Rockland county, N. Y. (Darto
    40).
  - Trap west of New York (Credne
    13).
  - Staten island (Britton, 81, pl. 15.
    '86*a*, p. 123).
  - Stony point (J. D. Dana, '80–'81,
    113).
- Of North America (Hitchcock and H
  '67, pp. 408–409).
- Of North Carolina (Anonymous, '6
  '75. Mitchell, '42. Willis, '8
  pp. 301–302).
  - Chatham county (W. R. Johnson,
    No. 3).
  - Coal outcrop at Murchison (Cha
    48).
  - Deep river coal field (Chance, '85,
    66. Emmons, '56, pp. 338–342.
    '58.)
  - Deep river and Dan river coal fie
    dow and Bannan, '66, p. 404).
  - Deep river mining and trans
    company's coal mines (W.
    son, '51, map. No. 4).
  - Newark area (Chance, '85, pl. op
  - Part of (W. R. Johnson, '51, map
  - Showing Newark about Wades
    etc. (Mitchel, '29, map op. p.
  - Showing outcrop of coal at Evans
    '85, p. 44).
  - Showing outcrop of coal near
    (Chance, '85, p. 27).

Map, geological, of North Carolina—Continued.

Showing outcrop of coal near the Gulf (Chance, '85, p. 38).

Showing position of coal-bearing areas (Kerr, '79).

Of Nova Scotia (Dawson, '45. Dawson, '78, 1st ed. Dawson, '78, map 2d and 3d ed. Gesner, '36. Jackson and Alger, '33).

Minas basin and Cobequid bay (Dawson, '47, pl. 5).

Of Pennsylvania (Frazer, '82, pl. [3]. Lesley, '86, op. p. 656. Lesley and d'Invilliers '85, frontispiece of volume. Macfarlane, '77, frontispiece. Putnam, '86c, pl. op. p. 179. H. D. Rogers, 58, vol. 2, in portfolio).

Adams county (Lesley and Frazer, '76).

Chester county (Frazer, '83, in pocket).

Cornwall iron mines near Lebanon (Lesley and d'Invilliers, '85).

Cumberland county (Lesley, '80).

Distribution of Newark rocks (C. E. Hall, '80, pl. op. p. 442).

Franklin county (Sanders, '81).

Fritz island mine (d'Invilliers, '83, in atlas).

Indicating drainage, etc., in Jurassic time (W. M. Davis, '89a, p. 233).

Iron mines near Boyertown (d'Invilliers, '83, in atlas).

Iron mines of Cumberland and York counties (d'Invilliers, '86, pl. op. p. 1437).

Iron ore deposits at Cornwall (d'Invilliers, 86a, p. 874).

Iron ore mines near Dillsburg (Frazer, '76d, pl. 2).

Lancaster county (Frazer, '80).

Lehigh and Northampton counties and a part of Berks county (d'Invilliers, '83, in atlas).

Mining districts of Chester and Montgomery counties (H. D. Rogers, '58, vol. 2, op. p. 674).

Near Philadelphia (C. E. Hall, '81, in pocket. C. E. Hall, '81, p. 21).

Newark rocks (Lesley, '64, op. p. 476).

Ore deposits in York and Adams counties (Frazer, '76, op. p. 64).

Pickering creek copper and lead mines (Lesley, '83, p. 177).

Portion of Montgomery and Bucks counties (Hall, '81, in pocket).

Trap dike across southeast Pennsylvania (Lewis, '85, pl. op. p. 440).

Trap dike near Flourtown, Pa. (C. E. Hall, '81, p. 23).

York county (Frazer, '80. Frazer, '85, pl. op. p. 391).

York and Adams counties (Frazer, '76, op. p. 196. Frazer, '77).

Of Prince Edward island, scale 25 miles to 1 inch (Dawson, '78, map, 2d and 3d ed. Dawson and Harington, '71, frontispiece. Ells, '84, accompanying).

Of South Carolina, Chesterfield county (Tuomey, '48. Lieber, '56, pl. 6).

Map, geological, of the United States. (Brewer, '90. C. H. Hitchcock, '74, pl. 12. C. H. Hitchcock, '86. Hitchcock and Blake, '74. Macfarlane, '79, pl. op. p. 216. McGee, '84. Marcou, '55. Marcou, '58, frontispiece. Marcou, '58, frontispiece. Marcou, '58, pl. 9. H. D. Rogers, '56, pl. 8).

Of the United States and the British provinces (Marcou, '53, on map in vol. 2. Marcou, '55a).

Of the United States, Canada, etc. (Lyell, '45, vol. 2, pl. 2. Bradley, '75).

Of the United States, eastern part of (Cleaveland, '22, frontispiece. Le Conte, '82, p. 289. Maclure, '09).

Of Virginia (Hotchkiss, '76, op. p. 46. Hotchkiss, '80. Rogers, '84).

Black heath coal mines (Clifford, '87, pl. 4).

Deep run coal mine (Clifford, '87, pl. 5).

Eastern part of, showing distribution of Mesozoic rocks (Heinrich, '78, pl. 5).

Midlothian coal mine (Heinrich, '76, pl. 3).

Piedmont coal fields (Daddow and Bannan, '66, p. 395).

The Richmond coal field (Clifford, '87, pl. 1).

The western part of (Benton, '86, pl. op. p. 261).

Of the world (Prestwich, '86, vol. 1, pl. 1).

Showing Newark area (E. Hitchcock, '56).

Geological sketch, of the United States (Foster, '69, pl. op. p. 273. Lyell, '45, pl. op. p. 75 in New York edition. Macfarlane, '77, pl. op. p, 3. Steel, '74, frontispiece).

Of coal fields of the United States. Indicates the position of the Richmond, Deep river, and Dan river coal fields (Macfarlane, '77, pl. op. p. 626).

Newark area in the United States (Chance, '85, pl. op. p. 66).

Marble hall, Pa. Trap dike near (C. E. Hall, '81, p. 75. Lewis, '85, p. 441. H. D. Rogers, '58, vol. 1, p. 214).

March's mill, Pa. Dip of conglomerate at (d'Invilliers, '83, p. 202).

Strike and dip (d'Invilliers, '83, p. 213).

MARCOU, JULES. **1849.**

Note sur le houille du conté de Chesterfield, près de Richmond (État de Virginie).

In Bull. Soc. Géol. de France, 2d ser., vol. 6, 1848-1849, pp 572-575.

Reviews previous determination of the geological position of the Richmond coal field, and proposes a new correlation based on additional evidence furnished by fossil plants and fishes.

MARCOU, JULES. **1853.**

A geological map of the United States and of the British provinces in North America; with an explanatory text, geological sections, and plates of the fossils which characterize the formations.

MARCOU, JULES—Continued.

Boston. [vol. 1], pp. i-viii, 1-92, pls. 1-8; [vol. 2], a geological map of the United States, etc.

For references to later editions of the geological map see Bulletin No. 7, 1884, of the U. S. Geological Survey.

Reviewed in Am. Jour. Sci., 2d ser., vol. 17, pp. 199-206; by W. P. Blake, ibid., vol. 22, pp. 383-388; by H. Agassiz, ibid., vol. 27, pp. 134-139.

Contains a list of synonyms of the Newark system and gives a brief account of the formation. A few characteristic fossils are figured, pp. 39-44, pls. 6-7.

Refers the Richmond area to the Trias, and the Newark rocks of North Carolina to the New Red sandstone.

MARCOU, JULES. 1855.

Résumé explicatif d'une carte géologique des États-Unis et des provinces anglaises de l'Amérique du Nord avec un profil géologique allant de la vallée du Mississippi aux côtes du Pacifique et une planche de fossiles.

In Bull. Soc. Géol. de France, 2d ser., vol. 12, pp. 813-936, pl. 21, and map.

Contains a general sketch of the characteristics, distribution, and stratigraphical relations of the Jura and Trias formations in North America. Discussion of the age of the Newark system.

MARCOU, JULES. 1855a.

Ueber die Geologie Vereinigten Staaten und der englischen provinzen von Nord-amerika.

In Petermann's Mitth., vol. 1, 1855, pp. 149-159, and map 15.

Brief account of the extent and characteristics of the Newark system of North America.

MARCOU, JULES. 1858.

Geology of North America, with two reports on the prairies of Arkansas and Texas, the Rocky mountains of New Mexico, and the Sierra Nevada of California.

Zurich, 4to, pp. i-viii, 1-144, 1-8, pls. 1-9, and a geological map of the United States.

Contains many statements concerning the geological position of the Newark system.

MARCOU, JULES. 1859.

Reply to the criticisms of James D. Dana, including Dana's two articles, with a letter of Louis Agassiz.

Zurich, pp. 1-40.

A reply to certain criticisms in reference to Jules Marcou's observations on the geology of North America. Several reviews of Marcou's writings are reprinted.

MARCOU, JULES. 1875.

Explication d'une seconde édition de la carte géologique de la terre.

Zurich, 4to, pp. 1-222, pl. 1.

Contains a short sketch of general geology, in which brief references are made to the "Trias" and "Jura" of North America, pp. 43-55; and an account of the geology

MARCOU, JULES—Continued.

of North America in which brief notic are given of the writings of various ologists. On the small map at the end the volume areas are indicated which occupied by the "Trias" and "Dy combined.

MARCOU, JULES. 1

American geological classification and nor clature.

Cambridge, Mass., pp. 1-75.

Refers briefly to the rocks of the Newark tem, pp. 31-32, 73.

MARCOU, JULES. 1

The Triassic flora of Richmond, Va.

In Am. Geol., vol. 5, pp. 160-174.

A review of "Contribution to the knowl of the older Mesozoic flora of Virgi by W. M. Fontaine; "Sur la présence le grès bigarré, des Vosges, de l'Acr chides rhombifolius, Fontaine" par Zeiller; "Die Lunzen-(Lettenkohl Flora in den "older Mesozoic beds o coal field of eastern Virginia," by D. and "Fossil fishes and fossil plants o Triassic rocks of New Jersey and Connecticut valley," by J. S. Newb

MARCOU, J. Cited on the age of the Ne system (Dewey, '57. Jones, '62, p. Lea, '58. Newberry, '88, p. 9. Zeille p. 698).

Richmond coal field, Virginia (Hull, '8 460).

MARCOU, J. Cited on extent of the Tri rocks in America (Archiac, '60, pp. 638).

Geological map of North America (Ma '59, pp. 26-30).

Newark flora (Marcou, '90).

Reproduction of geological map of the by (Prestwich, '86, vol. 1, pl. 1).

Review of geology of North Ameri (Agassiz, '59. J. D. Dana, '59).

Margaretville, N. S. Copper at (How, '69, Willimott, '84, p. 20, L.? 25, 26 L.).

Margerum's, S., quarry near Princeton, N. J. scription of (Cook, '81, p. 55).

Maria furnace, Pa. Iron ore near (H. D. Ro '58, vol. 2, p. 690).

Trap dikes near (H. D. Rogers, '58, vol 690).

Mariner's harbor, Staten island. Newark crop near (Hollick, '89).

Marion, N. J. Trap rock at (Ward, '79, p. 1

Marion, Pa. Boundaries of the Newark in Hall, '81, pp. 83-84).

Marlboro, Conn. Description of trap dike primary rocks near (Percival, '42, 423-424).

Marls in North Carolina. (Kerr, '75, p, 187).

MARSH, DEXTER. 1

[On the discovery of footprints in the stone of the Connecticut valley.]

In Am. Jour. Sci., 2d ser., vol. 6, pp. 272-

Describes the finding of footprints at se localities in the Connecticut valley.

TER. Cited on the discovery of fos-
otprints in the Connecticut valley
itchcock, '58, p. 8).
Footprints discovered by (Deane,
.212-214. E. Hitchcock, '55*a*, p. 186).
to specimens of footprints in the
et of (E. Hitchcock, '48).
to in connection with fossil foot-
(Macfarlane, '79, p. 63).
. **1863.**
of mineral localities in New Bruns-
Nova Scotia, and Newfoundland.
our. Sci., 2d ser., vol. 35, pp. 210–218.
many Newark localities.
. **1867.**
ions to the mineralogy of Nova Sco-
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our. Sci., 2d ser., vol. 44, p. 362–367.
in the Newark are mentioned.
. **1877.**
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America.
Assoc. Adv. Sci., Proc., vol. 26, 1878,
1–258, pl. op. p. 211.
a general summary of what is known
rning the reptilian life of the New-
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. **1887a.**
Jurassic mammals.
our. Sci., 3d ser., vol. 33, pp. 327–348,
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7, pp. 241–247, 289–299, pls. 6–9.
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ew genera and species.
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new American Dinosauria.
our. Sci., 3d ser., vol. 37, pp. 331–336.
brief descriptions of Dinosaurian
ins from the Connecticut valley.
. Cited in reference to fossils of the
ark system (Newberry, '88).
Mormolucoides articulatus (Scudder,
. 218).
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ecticut valley (Hull, '87, p. 86).
on footprints collected by Winchell,
. 186).
Boundaries of the Newark in (C. E.
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. 679).
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l near (Cook, '68, p. 190).
Pa. Trap dike near (Lewis, '85, pp.
146).
rry, Montague, Mass. Fossil foot-
ts at (E. Hitchcock, '58, pp. 49 et seq.).
, V. F. 1890.
traps of Nova Scotia, with notes on
r intrusives of Pictou and Antigonish
ties, N. S.
Geol., vol. 5, pp. 140–145.

MARSTERS, V. F.—Continued.

Describes North mountain and cape Blomidon, N. S. Suggests that the trap rocks there exposed were formed by a submarine eruption. Compares the trap with similar rocks in the Connecticut valley, and describes its microscopical characters. Describes trap dikes outside of the Newark area in eastern Nova Scotia.

Marsters mountain, N. S. Character of, and height of (Marsters, '90).

Marthas Vineyard. Newark debris in Tertiary rocks of (Shaler, '85*a*, p. 21).

Martials cove, N. S. Description of (Gesner, '36, pp. 192–194).

MARTIN, B. N. 1870.

[Remarks on the metamorphic origin of the trap rock forming the Palisades of the Hudson.]

In New York Lyc. Nat. Hist., Proc., vol. 1, 1870–'71, pp. 132–133.

Describes personal observations on the stratification and lithology of the rocks of the Palisades, which tend to support the metamorphic origin of the trap of that ridge as suggested by Wurtz.

MARTIN, D. S. 1870.

[Celadonite (?) from the trap rock of Weehawken, N. J.]

In New York Lyc. Nat. Hist., Proc., vol. 1, 1870–'71, pp. 130–131.

Mentions the discovery of the mineral referred to.

MARTIN, DANIEL S. 1876.

On the rocks of New York island and their relation to the geology of the Middle states.

In Liverpool Geol. Soc., Proc., vol. 3, pp. 118–120.

Describes the belt of gneiss passing through New York, Trenton, Philadelphia, etc., and shows that it divides the earlier from the latter Mesozoic beds. The opposite dips of the beds on the sides of this axis are noted.

MARTIN, D. S. 1883.

[Remark on the Newark system in New Jersey.]

In New York Acad. Sci., Trans., vol. 2, 1882–'83, p. 120.

Refers to a possible origin of the arkose near Hoboken, N. J., and states that the Newark rocks of New Jersey and of the Connecticut valley were probably united at the time of their deposition.

MARTIN, D. S. 1885.

[Remarks on the former connection of the Newark areas of New Jersey and of the Connecticut valley.]

In New York Acad. Sci., Trans., vol. 5, 1885–'86, pp. 19–20.

Refers to the mineralogical character of the "tide-water gneiss" separating the two Newark areas referred to, and expresses the opinion that these areas were united at the time of their deposition.

- **MARTIN, DANIEL S.** 1888.
  - Geological map of New York city and vicinity.
  - New York. A wall map accompanied by a pamphlet with the same title, pp. 1–14.
  - The map includes the northern part of the New York–Virginia area, and the pamphlet accompanying it gives a brief account of its more prominent features.
- **Martins cove, N. S.** Copper at (Gesner, '36, pp. 192, 193).
  - Minerals of (Gesner, '36, pp. 192, 193).
- **Martins dock, N. J.** Analysis of trap from (Cook, '68, p. 216).
  - Continuation of Palisade trap ridge at (D. S. Martin, '88, p. 9).
  - Description of the geology near (W. M. Davis, '83, pp. 276–277).
  - Detailed account of trap outcrop near (Darton, '90, pp. 65–66)
  - Dip in sandstone at (Cook, '82, p. 25).
  - Dip in shale at (Cook, '79, p. 30).
  - Dip near (Cook, '68, p. 196).
  - Indurated shale near (Darton, '90, p. 39).
  - Origin of trap rock near (Darton, '89, p. 138).
  - Section of trap and sandstone at (W. M. Davis, '83, p. 303, pl. 11)
  - Trap between sandstone near (Cook, '68, pp. 20, 202–205).
  - Trap dike near (Cook, '82, pp. 58–59, and pl. 6).
  - Trap rock at (Cook, '68, p. 178).
- **Martins head, N. B.** (Bailey, Mathews and Ells, '80).
  - Description of (Gesner, '40, pp. 22–23).
  - Lignite at (Dawson, '78, p. 99).
  - Lignite of (Bailey, Mathews and Ells, '80, p. 21D).
  - Minerals of (Gesner, '40, p. 22).
  - Position of (Bailey, Mathews and Ells, '80, map No. SE., accompanying).
  - Rocks of (Bailey Mathews and Ells, '80, 21D. Gesner, '40, p. 22)
  - Trap of (Gesner, '40, p. 22).
- **Martinsville, N. J.** Boundary of Second mountain trap at (Cook, '68, p. 183).
  - Building stone near (Cook, '68, p. 509).
  - Copper ores near (Cook, '68, p. 678).
  - Description of quarries at (Cook, '81, pp. 54–55).
  - Dip in sandstone at (Cook, '82, p. 29).
  - Dip near (Cook '68, p. 198).
  - Diverse dips near (Nason, '89, p. 18).
  - Exceptional dip near (Nason, '89, p. 18).
  - Flagstone at (Cook, '68, p. 521).
  - Limestone near (Cook, '68, p. 214. Cook, '82, p. 42).
  - Plant remains in sandstone near (Nason, '89, pp. 23, 27).
  - Quarries at (Cook, '79, p. 20. Cook, '81, pp. 54–55).
  - Sandstone quarries at (Cook, '79, p. 23).
  - Sandstone quarries near (Shaler, '84, pp. 143, 144).
  - Thickness of strata at (Cook, '68, p. 201).
  - Trap boundary at (Cook, '68, p. 189).
  - Vesicular trap near (Darton, '90, p. 28).
- **Maryland.** Boundaries of the Newark in (Heinrich, '78, p. 236. W. B. Rogers, '40, p 63–64).
  - Brief description of the Newark system (Ducatel, '37. H. D. Rogers, '58, vol. pp. 759–765. Tyson, '60, p. 41).
  - Brief mention of sandstone and conglome in (Taylor, '35a, p. 320).
  - Brief reference to conglomerate in (Duc '40).
  - Building stone in (Tyson, '60, appendix, 3, 5–6).
  - General dips (J. D. Dana, '75, p. 419).
  - Limestone (Potomac marble) in (Shaler, '8 177 pl. 46)
  - List of railroad stations on the Jurassic Triassic formations in (Uhler, '79, pp. 177).
  - Quarries of limestone in (Shaler, '84, p.
  - Quarries of sandstone in (Shaler, '84, p.
- **Massachusetts.** Account of fossil plants fro Hitchcock, '43*b*, pp. 295–296).
  - Account of the Newark in (A. Smith, ' 218).
  - Additional facts concerning a fossil from mount Tom (E. Hitchcock, '60).
  - Additional facts concerning *Otozoum* from (E. Hitchcock, '55*b*).
  - Boundaries of the Newark in (A. Smit pp. 218–219)
  - Brief account of fossil footprints in ('45, vol. 1, pp. 252–255).
  - Brief account of geology of Ham county (Nash, '27, pp. 246–247).
  - Brief account of mounts Tom and Ho (E Hitchcock, '18, pp. 105, 108).
  - Brief account of Newark system in (Hitchcock, '71. Lyell, '54).
  - Brief account of region about mount and Holyoke (E. Hitchcock, '43, p. 1
  - Brief account of trap rocks in (Porter,
  - Brief description of the trap and tra glomerate of (E. Hitchcock, '44*e*, pp
  - Brief discussion of Newark rocks of, in nection with other localities (W. B. ers, '54).
  - Brief reference to the north end of Ne system in (C H. Hitchcock, '77*a*, p.
  - Brief remarks on fossil footprints fou Northampton (E. Hitchcock, '45*c*).
  - Character and mode of formation of the ark rocks of (Jackson, '41)
  - Collecting fossil fish at Sunderland (Silli '21*a*).
  - Description and illustration of Newark f from (Newberry, '88).
  - Description and illustrations of footp from Turners falls (Deane, '56).
  - Description of the Deerfield dike (Eme '82).
  - Description of five new species of fossil prints from (E. Hitchcock, '43*a*).
  - Description of footprints from (E. Hitch '58).
  - Description of footprints found at Tu falls (Deane, '45*b*).

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Description of footprints of *Tarsodactylus expansus* from (C. H. Hitchcock, '66).

Description of fossil fishes from (W. C. Redfield, '41).

Description of fossil footprints from Turners falls in (Deane, '45. Deane, '47).

Description of a fossil shell from near mount Tom (E. Hitchcock, jr., '56).

Description of *Gigandipus* from Turners falls (E. Hitchcock, '56*a*).

Description of *Mormolucoides articulatus* from (Scudder, '84).

Description of sections across the Connecticut valley in (E. Hitchcock, '55).

Description of tracks of a quadruped from Turners falls (Deane, '48).

Description of trap ridges in (E. Hitchcock, '35, pp. 408–410).

Description of trap tuff on the east side of mount Tom (E. Hitchcock, '24, pp. 245–247).

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Massachusetts—Continued.

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Deerfield mountains. In illustration of estimate of thickness of the Newark system (E. Hitchcock, '35, p. 224).

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Mettawampe through (Walling, '78, pl. op. p. 192).

Montague and Gill, between (E. Hitchcock, '41, p. 654).

Montague and Gill, between, figure showing (E. Hitchcock, '35, p. 416).

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Mount Toby and Deerfield, to illustrate an estimate of thickness (E. Hitchcock, '35, p. 224).

Mount Tom (E. Hitchcock, '47*a*, p. 200. E. Hitchcock, '58, pl. 3).

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- Showing junction of trap and sandstone (E. Hitchcock, '35, p. 421, E. Hitchcock, '41, p. 656).
- Showing trap and sandstone (W. M. Davis, '83, pp. 305–307, pl. 10).
- Through (Walling, '78, pl. op. p. 192).
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North Sugar Loaf mountain (Walling, '78, pl. op. p. 192).

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- Across the Connecticut valley at. After E. Hitchcock (W. M. Davis, '83, p. 280, pl. 9).
- Near, brief reference to (E. Hitchcock, 35, p. 221).

Massachusetts sections—Continued.

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	Page.
Succession of rocks in the first district	2
Trap rocks of Richmond and Rockland counties	278–283
Extent of the trap rocks of Richmond and Rockland counties	278–282
Origin of trap rocks of Richmond and Rockland counties	278–282
Sandstone conglomerate and shales of Richmond and Rockland counties	285–294
Red and gray conglomerate	286–287
Red sandstone or freestone	287
Red marl	288
Compact gray limestone	288
Red comglomerate limestone	288–289
Considerations on the origin of this formation	289–293
Condition under which the rocks were deposited	289–293
Geological age of the Red sandstone	293–294
Table of dips and strikes in Rockland county	616–617
Table of joints and veins (Richmond county)	625

MATHER, WILLIAM W.—Continued.

	Page.
Summary in reference to the age of the rocks of Richmond and Rockland counties	627

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MATTHEW, G. F. 1863.

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Contains a small map showing Newark rocks at Quaco Head, p. 248.

Notices briefly the unconformity of the Newark near Gardner's creek with the upturned Carboniferous rocks beneath, pp. 256, 258. Appended is a note by J. W. Dawson on fossil plants.

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In observations on the geology of southern New Brunswick, made principally during the summer of 1864 by Prof. L. W. Bailey, Messrs. Geo. F. Matthew, and C. F. Hartt, prepared and arranged, with a geological map, by L. W. Bailey, pp. 123–125, 129, and map.

Some errors in reference to the age of certain rocks made by Abraham Gesner, in reports on the geological survey of New Brunswick, from 1839–1841, are pointed out. The localities of Newark rocks are described in detail, together with descriptions of lithological characters, dip, trap intrusions, etc., pp. 123–125. On p. 129 is a table giving a "classification of the sediments of southern New Brunswick on physical grounds."

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the supposed absence of coal in the rk system.

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ɔn of trap hill near (Cook, '68, pp. 36).
per mine, N. J. Description of (H. gers, '40, pp. 163-164).
ove, Pa. Description of trap dike Frazer, '80, p. 30).
e, Pa. Description of trap dikes C. E. Hall, '81, pp. 19-20, 84).
rom (C. E. Hall, '78, p. 45).
to trap dikes near (C. E. Hall, '81, Lewis, '85, pp. 439-441).
om near, to near mount Holly (Fra-7, pp. 274-277, pl. op. p. 274).
:s near (C. E. Hall, '81, p. 19-20. , '85, p. 443).
s. Character of trap rock quarried P. Merrill, '84, p. 24).
ι. J. Description of (Cook, '82, p.

p in New Jersey. Brief account of ıer, '70).
J. Boundary of the Newark near . Rogers, '40, p. 118).
ı. Ash bed near, popular account . M. Davis, '91).
ınt of trap near (E. Hitchcock, '23, p. 49).
compositions of trap rock from near s, '75).
:y of, view of (Davis and Whittle, 5).

Meriden, Conn.—Continued.
Description of an ash bed near (W. M. Davis, '89b).
Description of geology near (W. M. Davis, '83, pp. 265-266).
Description of quarry near (Davis and Whittle, '89, pp. 112-113).
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Diagram showing geological structure near (W. M. Davis, '89, pl. 2).
Discussion of the origin of topographic features near (W. M. Davis, '89c).
Excursion to the Hanging hills of (J. D. Dana, '70).
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Map of trap ridges and faults near (W. M. Davis, 89c, p. 424).
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Notice of a bed of volcanic ash near (Chapin, '89).
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Below trap sheet in the Richmond area (W. B. Rogers, '54*b*).

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In connection with trap dikes in the Primary rocks of (Percival, '42, p. 317).

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In southern part of, description and discussion of (Hovey, '89, pp. 373, 374, 378).

Metamorphism, contact, in Connecticut—Cont'd.

Mention of Meriden areas (C. H. S. Davis, '70).

Near the trap rocks of (Jackson, '45).

Observations on, in connection with the trap sheets of (Davis and Whittle, '89).

In Massachusetts, an account of (E. Hitchcock, '35, pp. 421-425).

At the Simsbury copper mines (E. Hitchcock, '35, p. 229).

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Adjacent to trap sheets (Darton, '90).

At Belle mountain (H. D. Rogers, '40, pp. 151-152).

At Blackwell's mills (Cook, '68, p. 204).

At Goat hill (Rogers, '36, p. 156).

At Kings point (Darton, '83*a*).

At Paterson (J. H. Hunt, '90).

At Paterson beneath trap (H. D. Rogers, '36, pp. 160-161.

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At Sourland mountain (Cook, '68, p. 191. H. D. Rogers, '40, pp. 152-158).

At Smith's hill (H. D. Rogers, '40, pp. 151-152).

At Summerville, in Bridgewater copper mine (H. D. Rogers, '40, pp. 147-148).

At Wilburtha, mention of (Nason, '89, p. 32).

Discussion of (H. D. Rogers, '40, pp. 156-158).

In connection with copper mines of (H. D. Rogers, '40, pp. 158-165).

In connection with the trap rocks of (H. D. Rogers, '40, pp. 145-158).

In shales and sandstones beneath the trap of the Palisades (Russell, '80, pp. 35-45).

Mention of (Cook, '71, pp. 55-56).

Near Baptistown (H. D. Rogers, '40, p. 131).

Near Chatham (H. D. Rogers, '40, p. 133).

Near Flemington, Clinton, etc. (H. D. Rogers, '40, pp. 123-124).

Near Fort Lee (Cook, '68, p. 208).

Near Lambertsville (H. D. Rogers, '36, pp. 161-162).

Near New Vernon (H. D. Rogers, '40, p. 133).

Near Plainfield, mention of (Russell, '80, p. 41).

Near Princeton (H. D. Rogers, '40, pp. 151-152).

Near Rocky hill (H. D. Rogers, '40, pp. 149, 151).

In New York, beneath the Palisades (Mather, '43, p. 285).

In Rockland county (Mather, '43, pp. 288-289).

Near Closter (Darton, '90, p. 51).

In North Carolina, brief reference to (Tuomey, '46, pp. 48, 68).

In the Deep river coal field (Wilkes, '58. p. 7).

In Nova Scotia (Chapman, '78, p. 112. Jackson and Alger, '33, pp. 266-267, 278, 280, 286).

Metamorphism, contact, in Massachusetts—Cont'd.
Absence of (Dawson, '47, p. 58).
At Blomidon (Ells, '85, p. 7E. Jackson and Alger, '33, p. 257).
At Sandy cove (Gesner, '36, pp. 181–182).
At Swans creek (Gesner, '36, p. 254).
Near Two islands (Gesner, '36, p. 254).
Observations on (Emmons, '36, p. 336).
In Pennsylvania (H. D. Rogers, '29, p. 22).
At Fairfield (H. D. Rogers, '58, vol. 2, p. 684).
At New Hope (H. D. Rogers, '48).
At New Hope, brief account of (H. D. Rogers, '36, p. 162).
At Point Pleasant, brief account of (Lewis, '85, p. 452).
Detailed account of (H. D. Rogers, '58, vol. 2, pp. 684–692).
In Adams county (H. D. Rogers, '58, vol. 2, p. 691).
In Berks county (d'Invilliers, '83, pp. 199–200, 203–204).
In Chester and Montgomery counties (H. D. Rogers, '58, vol. 2, pp. 676–679).
Near Fairfield (H. D. Rogers, '58, vol. 2, p. 691).
Near Gettysburg (H. D. Rogers, '58, vol. 2, p. 692).
Near Greshville (d'Invilliers, '83, p. 211).
Near Harleysville, brief description of (Lewis, '82).
Near Littlestown (H. D. Rogers, '58, vol. 2, p. 680).
Near New Hope (H. D. Rogers, '58, vol. 2, pp. 673, 674).
Near St. Mary's (H. D. Rogers, '58, vol. 2, p. 708).
Near York Haven (H. D. Rogers, '58, vol. 2, pp. 677, 678).
In South Carolina, brief account of (Tuomey, '48, pp. 68, 103–104, 113).
In Virginia, at Clover hill, mention of (De La Beche, '48, p. lxvi).
Detailed account of (W. B. Rogers, '39, pp. 82–83. W. B. Rogers, '40, pp. 64–69).
In Prince William county (W. B. Rogers, '55c).
In Richmond coal field (Lyell, '47, pp. 270–274. W. B. Rogers, '54a).
Remarks on the occurrence of natural coke in (Heinrich, '75).
Of coal near trap dikes in the Richmond coal field (Clifford, '87, pp, 11, 13–14).
On Prince Edward island (Dawson and Harrington, '71, p. 22).
Reference to (Russell, '78).
Sandstone changed to syenite (Frazer, '76b).
In Connecticut, at junction of trap and sandstone (Chapin, '35).
By trap, observations of Lyell (De La Beche, '48, p. lxvi).
Detailed description of (Percival, '42, pp. 319–321).
Of Connecticut valley sandstone (J. D. Dana, '73, vol. 5, p. 431).
Of rocks forming the Palisades of the Hudson (Wurtz, '70).
Of shales and sandstones in New Jersey (Cook, '82, pp. 33, 37).

Metamorphism, contact—Continued.
Of the trap rock of the Palisades, N. J. (B. N. Martin, '70).

Mettawampe, Mass. Section across (E. Hitchcock, '58, pp. 9, 10, pl. 3).
Section across Connecticut valley at (E. Hitchcock, '58, pl. 3).
Section through (Walling, '78, pl. op. p. 192).
Study of stratigraphy near (Walling, '78).

Meyerville, N. J. Trap ridge near (Cook, '82, p. 56).

Microscopical examination of sandstone from Connecticut valley (Hawes, '78).

Middlebrook, N. J. Brief account of sandstone and trap at (H. D. Rogers, '40, p. 127).
Dip in shale along (Cook, '82, p. 25).
Dip near (Cook, '68, p. 196. Cook, '68, p. 198).
Strata exposed near (H. D. Rogers, '40, p. 128).

Middle creek, Pa. Boundary of the Newark along (H. D. Rogers, '58, vol. 2, p. 668).

Middlefield, Conn. Bituminous shale near (Percival, '42, p. 446).
Brief account of trap at (Shepard, '32).
Description of fossil-fish locality at (Anonymous, '38).
Description of fossil fishes from (W. C. Redfield, '41).
Description of trap ridges near (Davis and Whittle, '89, p. 114. Percival, '42, pp. 355–361).
List of fossil fishes from (De Kay, 42).
Mention of *Catopterus gracilis* from (J. D. Dana, '75, p. 417).

Middle Haddam, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 423, 424).
Trap ridges near (Percival, '42, pp. 361, 449).

Middlesex, Conn. Relation of trap and sandstone near (Welpley, '45, pp. 62, 63).

Middletown, Conn. Bituminous shale, with fossil fishes, at (E. Hitchcock, '41, p. 443).
Brief account of fossil fishes from (E. Hitchcock, '37, p. 267).
Brief account of sandstone near (E. Hitchcock, '35, pp. 220–221).
Brief reference to finding of fossil footprints at (Anonymous, '38a).
Brief reference to footprints, fossil bones, and fossil plants found at (Silliman, '37).
Brief remarks on shrinkage cracks at (J. Johnson, '43).
Descriptions and figures of fossil fishes from (Newberry, '88).
Description of fossil-fish locality at (Anonymous, '38).
Description of fossil footprints from (E. Hitchcock, 41, pp. 477, 478, pls. 30–48; pp. 478–501. E. Hitchcock, '58).
Description of scenery near (E. Hitchcock, '23, vol. 7, p. 4).
Description of trap ridges near (Percival, '42, pp. 356–360).
Early discovery of fossil footprints at (E. Hitchcock, '36, p. 309).
First discovery of fossil footprints at (Barratt, '37).

Middletown, Conn.—Continued.
Fossil fishes found near (Brongniart and Silliman, '22. E. Hitchcock, '35, pl. 14 in atlas, p. 238).
Fossil footprints from (E. Hitchcock, '58, pp. 50 et seq.).
Fossil plants from (E. Hitchcock, '41, p. 453).
List of fossil fishes from (De Kay, '42).
Localities of fossil footprints in (E. Hitchcock, '41, p. 467).
Locality for fossil footprints (E. Hitchcock, '48, p. 132).
Mention of the finding of fossil fish at (Percival, '42, p. 442).
Mention of the discovery of footprints at (W. C. Redfield, '38).
Overflow trap sheets near (W. M. Davis, '88, p. 465).
Reference to a locality for fossil fish (J. H. Redfield, '36).
Reference to fetid limestone in (E. Hitchcock, '41, p. 444).
Reference to limestone in (E. Hitchcock, '35, p. 218).
Remarks on fossil fishes from (Harlan, '34, pp. 92–94).
Remarks on fossil footprints at (Barratt, '45).
Report of the finding of coal at (E. Hitchcock, '23, vol. 6, p. 63).
Sandstone hills near (Percival, '42, pp. 448–449).
See Whitestown.

Middletown, Pa. Boundary of the Newark area of Pennsylvania near (Lea, '58, p. 92).
Boundary of the Newark near (C. E. Hall, '81, p. 53. H. D. Rogers, '58, vol. 2, p. 669).
Description of the Conewago hills near (Gibson, '20).

Middletown mountain, Conn. Description of (Percival, '42, p. 351).
Detailed study of the geological structure near (W. M. Davis, '89).
Fault near (W. M. Davis, '88, p. 474).
Trap ridges near (Percival, '42, p. 348).

Middletown station, N. S. Iron ore near (Harrington, '74, p. 207).

Middletown township, Pa. Report on the geology of (C. E. Hall, '81, p. 53).

Midland, N. J. Course of trap ridge near (Nason, '89, p. 34).

Midlothian, Va. An account of coal mining at (Daddow and Bannan, '66, p. 398).
Analysis of coal from (Clifford, '87, p. 10. W. R. Johnson, '51, p. 12. Silliman and Hubbard, '42).
Analysis of natural coke from near (Clarke, '87, p. 146. Raymond, '83).
Boundary of Newark area near (Heinrich, '78, p. 230).
Character and efficiency of coals from (W. R. Johnson, '50, pp. 133, 134, and table, op. p. 134).
Coal mines at (Lyell, '47, p. 266).
Condition of coal mines at (Clifford, '87, pp. 2, 16).
Depth of coal mine at (Marcou, '49, p. 573).

Midlothian, Va.—Continued.
Exploration with diamond drill at (Heinrich, '74).
Diamond drill explorations at (Heinrich, '75*a*).
Isolated coal basins near (Heinrich, '78, p. 232).
Natural coke at (Clifford, '87, pp. 11, 13–14).
New shaft at, depth of (W. B. Rogers, '43*b*, pp. 535–537).
Observations on the geology near (Clifford, '88).
Plan of coal-bearing rocks at (Clifford, '87, pl. 3).
Reference to faults at (Fontaine, '79, p. 36).
Section of coal-bearing rocks at (Clifford, '87, p. 23, pl. 3).
Section of coal seams at, after Heinrich (Chance, 85, p. 22).
Section of natural-coke seams near (Raymond, '83).
Test of coal from (Emmons, '56, p. 249).
Trial of the coal of, for heating purposes (W. R. Johnson, '44, pp. 420–448).

Midlothian coal mine, Va. Analysis of coal from (Williams, '83, p. 82).
Brief account of (Daddow and Bannan, '66, p. 401. Macfarlane, '77, p. 507).
Depth of (Taylor, '48, p. 50).
Depth of shaft at (Lyell, '47, p. 264).
Description of (W. B. Rogers, '36, pp. 54–60. Woodridge, '42, pp. 6–8. Heinrich, '73).
Detailed section in (Heinrich, '78, pp. 256–260, pl. 6).
In 1876 (Heinrich, '76*a*).
Map and section of (Heinrich, '76, pl. 3).
Notes on (Taylor, '35, pp. 284, 285).
Recent mining at (Hotchkiss, '83*a*).
Section at (Lyell, '47, p. 265).
Thickness of coal in (Taylor, '35, p. 282).

Milburn, N. J. Boundary of First mountain trap near (Cook, '68, pp. 180, 181. Cook, '68, p. 182).
Boundary of Second mountain trap at (Cook, '68, p. 183).
Course of trap ridge near (Cook, '82, p. 49).
Gap in First mountain at (Cook, '82, p. 50).
Thickness of trap sheet near (Darton, '90, p. 20).

Milford, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 413, 414).

Milford, N. J. Analysis of flagstone from (Cook, '68, p. 516).
Bearing of joints at (Cook, '68, p. 201).
Brief description of fossil footprints found near (Eyerman, '86).
Conglomerate near (Cook, '68, p. 209. Cook, '82, pp. 21–22. Cook, '82, p. 39. Nason, '89, p. 16).
Descriptions and figures of fossil plants from (Newberry, '88).
Description of conglomerate at (Nason, '89*a*, p. 67).
Description of fossil fucoid from (Lewis, '80*b*).
Description of sandstone and conglomerate near (H. D. Rogers, '40, p. 124).
Description of variegated conglomerate near (H. D. Rogers, '36, p. 147).

ilford, N. J.—Continued.

Detailed description of calcareous conglomerate near (H. D. Rogers, '40, pp. 140–141).

Detailed description of sandstone and shale near (H. D. Rogers, '36, pp. 151–152).

Dip in conglomerate at (Cook, '68, p. 209).

Dip in flagstone at (Cook, '68, p. 521).

Dip in sandstone, shale and conglomerate at (Cook, '82, p. 27).

Dip in shale near (Cook, '82, p. 27).

Dip near (Cook, '68, p. 198).

Dip of red shale and flagstone near (Cook, '79, p. 29).

Dip of variegated conglomerate near (H. D. Rogers, '36, p. 147).

Faults near (Cook, '79, p. 33. Cook, '82, p. 16).

Flagstone at (Cook, '68, p. 521).

Flagstone quarries near (Cook, '79, p. 20. Cook, '79, p. 25. Cook, '81, p. 64. Shaler, '84, p. 144).

Flagstone quarry near, description of (Cook '81, p. 64).

Footprints at (Cook, '79, p. 28).

Footprints on flagstone near (Nason, '89, p. 28).

Joints at (Cook, '68, p. 521).

List of fossil footprints and plants from, see (Eyerman, '89).

List of fossil footprints from (C. H. Hitchcock, '88, pp. 122, 23).

Mention of fossil plants found at (Newberry, '88, p. 12).

Mention of the occurrence of ripple-marks, sun cracks, raindrop impressions and footprints at (Russell, '78, p. 225).

Plant remains in flagstone near (Nason, '89, p. 27).

Red shales near (Nason, '89, p. 22).

Reference to, a footprint locality (C. H. Hitchcock, '88, p. 122).

Reference to fossil footprints from (C. H. Hitchcock, '89).

Thickness of strata at (Cook, '68, p. 201).

Unconformity of variegated conglomerate and older rocks near (H. D. Rogers, '36, p. 147).

Vegetable impressions at (Cook, '79, p. 27).

Milford, Pa. Mention of reptilian remains from the Newark rocks near (Dewey, '57).

Milford to Trenton, N. J. Section from (Cook, '79, p. 28).

Milton, N. J. Synclinal axis near (H. D. Rogers, '40, p. 128).

Milton grove, Pa. Boundary of the Newark near (Frazer, '80, p. 13).

Description of geology near (Frazer, '80, p. 37).

Millbaugh hill, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).

Millbrook, N. J. Boundary of Newark along (Cook, '68, p. 175).

MILLER, S. A. 1879–1881.

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In Cincinnati Soc. Nat. Hist., Jour., vol. 2, pp. 140–161, 223–244; vol. 3, pp. 9–32, 79–118, 165–202, 245–288; vol. 4, pp. 3–46, 93–144, 183–234.

MILLER, S. A.—Continued.

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Millers falls, Mass. Brief account of copper ores at (E. Hitchcock, '35, p. 72)

Millers river, Mass. Conglomerate at the mouth of (E. Hitchcock, '35, p. 214).

Millington, N. J. Abandoned quarries near (Cook, '81, p. 55).

Boundary of Long hill trap near (Cook, '68, p. 187).

Character of trap rock near (Darton, '90, p. 34).

Course of trap ridge near (Cook, '82, p. 56).

Dip at (Cook, '68, p. 198).

Dip in sandstone near (Cook, '79, p. 30).

Dip in shale and sandstone at (Cook, '82, pp. 29–30).

Lower contact of trap sheet near (Darton, '90, p. 34).

Sandstone above trap at (Cook, '68, p. 201).

Sandstone quarry near (Cook, '79, p. 23).

Millport, Pa. Boundary of the Newark near (Frazer, '80, pp. 38–39).

Boundary of the Newark at (H. D. Rogers, '58, vol. 2, p. 668).

Mill rock, Conn. Brief account of (Whelpley, '45, p. 62).

Contact metamorphism at (Percival, '42, pp. 436–438).

Contact phenomena at (Percival, '42, pp. 429–430).

Critical study of origin of (J. D. Dana, '91).

Description of trap ridges near (Percival, '42, pp. 396–397)

Example of a dike changing to an intruded sheet (Percival, '42, p. 300).

Garnets in the trap rock of (E. S. Dana, '77).

Origin of form of (Whelpley, '45, p. 64).

Structure connected with (Percival, '42, p. 438).

Mills's colliery, Va. Analysis of coal from (Clifford, '87, p. 10. Williams, '83, p. 82).

Description of (W. B. Rogers, '36, p. 54).

Notes on (Taylor, '35, pp. 284, 285).

Thickness of coal in (Taylor, '35, p. 282).

Mills's (pit). Analysis of coal from (Williams, '83, p. 82).

Mills, Reid & Co. shaft, Va. Analysis of coal from (Clifford, '87, p. 10. Williams, '83, p. 82).

Mill station, Pa. Mud rock from (C. E. Hall, '78, p. 41).

Millstone in North Carolina (Kerr, '75, p. 305).

Millstone, N. J. Dip in shale at (Cook, '82, p. 25).

Dip near (Cook, '68, p. 197).

Milltown, Pa. Sandstone from (C. E. Hall, '78, p. 52).

Milltown, N. J. Altered shale near (Cook, '68, p. 214).

Analysis of indurated shale from (Cook, '68, pp. 384-385).

Boundary of Newark at (Cook, '68, p. 176).

Dip at (Cook, '68, p. 196).

Dip in shale at (Cook, '82, p. 25).

Dip in indurated shale near (Cook, '82, p. 27).

Dip near (Cook, 68, p. 197).

Sandstone quarry at (Cook, '79, p. 23).

Millway, Pa. Boundary of the Newark near (Frazer, '80, p. 15).

Miminegash, P. E. I. Analysis of limestone from (Dawson and Harrington, '71, p. 41).

Fossil plants from (Bain and Dawson, '85, pp. 156-158).

Minas basin, N. S. Description of Newark rocks on shores of (Dawson, '47, pp. 51-55. Ells, '85, pp. 6-7E).

Description of north side of (Dawson, '78, p. 99).

Description of rocks at (Gesner, '43).

Discussion of the geology near (Dawson, '78, p. 110).

Minerals of (Willimott, '84, pp. 24L-28L).

Newark outcrops on the shore of (Chapman, '78, p. 112).

Scenery of (Dawson, '78, p. 101).

Minas bay, N. S. Section on north shore of. After J. W. Dawson (W. M. Davis, '83, p. 281, pl. 9).

Mine brook, N. J. Dip at (Cook, '68, p. 198).

Dip near (Cook, '68, p. 199).

Mine mountain, N. J. Boundary of Newark near (Cook, '68, p. 175).

Mineralogy. On datholite from Bergen hill, N. J. (E. S. Dana, '72).

On the minerals of trap (J. D. Dana, '45).

Minerals in amygdaloid (Jackson, '59a).

In Newark of Massachusetts, brief account of (E. Hitchcock, '35, pp. 228-234).

In New Brunswick, Nova Scotia, and New Foundland, localities of (Marsh, '63).

In New Jersey (Cook, '68, pp. 218-225).

Of Bergen hill, N. J. (Chamberlin, '83).

Description of (Beck, '43).

List of, from the Weehawken tunnel (Darton, '82).

List of (Seymour, '68).

New Brunswick and Somerville, N. J., observations on (Beck, '39).

Paterson, N. J. (J. H. Hunt, '90).

Paterson, N. J., description of (J. H. Hunt, '90).

Somerville copper mine, N. J. (Torry, '22).

Of the trap of Massachusetts, an account of (E. Hitchcock, '35, pp. 425-431).

Of the trap rocks of Massachusetts (E. Hitchcock, '41, pp. 660-663).

In Nova Scotia (Gesner, '36, p. 177-184, 188, 191-193. (Jackson and Alger, '33, p. 284. Willimott, '84).

Account of the collecting of (Emmons, '36, pp. 345—351).

Minerals—Continued.

In Nova Scotia at cape Blomidon, mention of (Marsters, '90, p. 4).

Mode of formation (Dawson, '78, p. 93).

At shore of Minas basin (Dawson, '47, pp. 54-55).

Catalogue of localities (How, '69, pp. 202—208).

In Nova Scotia with localities (J. W. Dawson, '78, pp. 113-115).

Of Staten island, N. Y. (Chamberlin, '87).

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Trap rock near (H D. Rogers, '58, vol. 2, p. 709).

Minishecongo creek, N. Y. Dip and strike near (Mather, '43, p. 617).

Red marl near (Mather, '43, p. 288).

Mink cove, N. S. Trap of (Jackson and Alger, '33, pp. 225-226).

Minzi mountain, Pa. Conglomerate at (d'Invilliers, '83, p. 203).

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HILL, SAMUEL L.—Continued.
ew York, pp. 1-40.
entions a fossil fern from Belleville, N. J., p. 6

HILL, SAMUEL L. 1828.
lecture on some parts of the natural history of New Jersey, delivered before the Newark Mechanic Association [etc.].
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neague falls, Mass. An account of obscure fossils found at (E. Hitchcock, '41, p. 462).
ocalities of fossil footprints near (E. Hitchcock, '41, p. 466).
eference to fetid limestone in (E. Hitchcock, '41, p. 444).

TER, W. G. Analysis of the trap of West Rock, Conn., by (J. D. Dana, '73, vol. 6, p. 106).

eetown, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 73).

lusks, fossil, absence of, from the Newark rocks (Lesley, '83, p. 213).
From Massachusetts, brief account of (E. Hitchcock, '35, p. 239).
From North Carolina (Emmons, '57, pp. 40-42, 134).
Brief account of (Emmons, '56, pp. 322-323).
List of (Kerr, '75, p. 147).
From Phœnixville, Pa., description of (Conrad, '58),
Mention of (Wheatley, '61, p. 43).
Remark on the finding of (Briton, '85).
Of the Newark system, brief sketch of (H. D. Rogers, '58, vol. 2, pp. 760-761).
Summary concerning (Miller, '79-'81, vol. 2, pp. 242-243).

mouth Junction, N. J. Black shales near (Nason, '89, p. 31).
Boundary of the Newark near (Cook, '89, p. 11. Cook, '68, p. 176).
rap boundary near (Cook, 68, p. 189).
rap rock near (Cook, '68, p. 189).

eacy hill, Pa. Trap dike (d'Invilliers, '83, pp. 200, 201).
rap dikes near, description of (H. D. Rogers, '58, vol. 2, p. 686).

oe, Pa. Boundary of the Newark near (H. D. Rogers, '41, pp. 16, 38).
onglomerate at (H. D. Rogers, '58, vol. 2, p. 681).
ontact of Newark and Paleozoic rocks at (H. D. Rogers, '58, vol. 2, p. 681).
Dip at (H. D. Rogers, '58, vol. 2, p. 681).
Dip of brecciated conglomerate near (C. E. Hall, '83, p. 247).

son, Conn. Description of trap dikes in Primary rocks near (Percival, '42, p. 426).

tague, Mass. Building stone quarried in (E. Hitchcock, '41, p. 181).
Character of rocks exposed at (J. D. Dana, '83, p. 385).

Montague, Mass.—Continued.
Conglomerate in (E. Hitchcock, '35, p. 214. E. Hitchcock, '41, p. 442).
Fossil fern from, reference to (E. Hitchcock, jr., '55, p. 25).
Fossil footprints from (E. Hitchcock, '58, pp. 49 et seq. D. Marsh, '48, p. 272).
Description of (E. Hitchcock, '36, pp. 320-325. E. Hitchcock, '41, pp. 478-501. E. Hitchcock, '58).
Discovery of (E. Hitchcock, '36, pp. 307-308. E. Hitchcock, '58, p. 4).
Discussion concerning (E. Hitchcock, '36, p. 334).
Locality for, in (E. Hitchcock, '48, p. 132).
Fossil plants from (E. Hitchcock, '41, p. 452).
Reference to (E. Hitchcock, '43*b*, p. 296, pl. 12).
Mormolucoides articulatus from, description of (Scudder, '84).
Relation of the trap rock in, to associated rock (E. Hitchcock, '41, p. 653).

Montague and Gill, Mass. Section between (E. Hitchcock, '35, p. 416. E. Hitchcock, '41, p. 654).

Montague falls, Mass. Dip of strata at (A. Smith, '32, p. 221).
Mention of the finding of fossil plants at (A. Smith, '32, pp. 219-220).

Montclair, N. J. Bored well at (Cook, '85, p. 122).
Boundary of First mountain trap near (Cook, '68, pp. 180, 181).
Elevation of First mountain at (Cook, '82, p. 49).
Vesicular trap near (Darton, '90, p. 28).

Montevideo, Conn. Description of scenery near (E. Hitchcock, '23, vol. 7, p. 5).
Description of trap ridges near (Percival, '42, p. 393).

Montgomery county, N. C. An account of the Newark in (Mitchell, '42, pp. 130-134).

Montgomery county, Pa. Description of a part of the Newark in (C. E. Hall, '81).
Geological map of a portion of (C. E. Hall, '81).
Map of mining district of (H. D. Rogers, '58, vol. 2, op. p. 674).
Mention of lead and copper ores of (Lyell, '54, p. 13).
Report on the geology of (C. E. Hall, '81. Lesley, '85, pp. lxxx-lxxxi, pl. 43).

Monticello, S. C. Description of trap dikes near (Tuomey, '44, p. 12).

Montpelier, Va. Boundaries of Newark near (Heinrich, '78, p. 237).

Montville, N. J. Boundary of Newark at (Cook, '68, p. 175).
Boundary of trap hill near (Cook, '68, p. 186).
Boundaries of Newark system near (Cook, '89, p. 11. H. D. Rogers, '40, p. 118).
Character and dip of strata near (H. D. Rogers, '40, p. 135).
Conglomerate at (Cook, '68, pp. 210-211. Cook, '82, p. 21. Nason, '89, p. 40).
Description of variegated conglomerate at (H. D. Rogers, '36, p. 148).

- **Montville, N. J.**—Continued.
  - Detailed description of calcareous conglomerate near (H. D. Rogers, '40, p. 137).
  - Dip in conglomerate at (Cook, '82, p. 30).
  - Diverse dips near (Nason, '89, p. 19).
  - Trap conglomerate near (Nason, '89*a*, p. 67. Nason, '90).
  - Trap outcrops near (Cook, '82, p. 55).
- **MOODY, P.** Cited on the discovery of fossil footprints in the Connecticut valley (E. Hitchcock, '48, p. 215).
  - Reference to fossil footprints found by (Macfarlane, '79, p. 63).
- **Moore county, N. C.** Account of the Newark in (Mitchell, '42, pp. 130-134).
- **Moore river, N. S.** Dip of Newark rocks near the mouth of (Dawson, '47, pp. 52-53).
  - Dip of sandstone near (Dawson, '78, p. 103).
  - Exposures of Newark rocks near (Dawson, '47, p. 53).
  - Fault near the mouth of (Dawson, '47, p. 53).
  - Junction of Trias and Carboniferous near (Dawson, '78, p. 103).
  - Unconformity at base of Trias near (Dawson, '78, p. 103).
- **Moore's hill, Conn.** Concerning trap ridges near (Percival, '42, p. 382).
- **Moore's hill, N. J.** Dip in shale at (Cook, '82, p. 26).
  - Dip near (Cook, '68, p. 199).
- **Moore's quarry, near Greenburg, N. J.** (Cook, '81, p. 57).
- **Moore's station, N. J.** Dip near (Cook, '68, p. 197).
  - Dip in shale at (Cook, '82, p. 26).
- **Morden, N. S.** Brief account of amygdaloid near (Honeyman, '88).
  - Minerals near (Willimott, '84, p. 26L).
- **Morehouse hill, N. J.** Description of (Cook, '68, pp. 185, 186. Cook, '82, p. 56).
- **Moreland, Pa.** Boundary of the Newark in (C. E. Hall, '81, pp. 61-62).
- **Moreland township, Pa.** Report on the geology of (C. E. Hall, '81, pp. 61-64).
- **Morgan's mills, Pa.** Boundary of the Newark near (C. E. Hall, '81, pp. 21, 61).
  - Composition of conglomerate near (C. E. Hall, '81, p. 24).
  - Conglomerate at (C. E. Hall, '81, p. 24. H. D. Rogers, '58, vol. 1, p. 160).
- **Morgantown, Pa.** Boundary of the Newark near (Frazer, '80, p. 15. H. D. Rogers, '58, vol. 2, p. 668).
  - Description of trap dikes near (H. D. Rogers, '58, vol. 2, p. 687).
  - Iron mine near (H. D. Rogers, '39, p. 22).
- **Morganville, Pa.** Boundary of the Newark near (Lesley, '85, p. lxxxi).
- **Morris county, N. J.** Note on the discovery of fossil fishes in (Silliman, '39).
- **Morris's cove, Conn.** South end of Newark area at (Percival, '42, p. 426).
- **Morris hill, Paterson, N. J.** Columnar trap at (Cook, '68, pp. 202-203).
  - Junction of trap and sandstone at (Cook, '82, pp. 50-51).
  - Trap rock quarried in (Cook, '81, p. 62).
- **Morris Plains, N. J.** Boundary of Newark in (Cook, '68, p. 175).
  - Section from, to Jersey City, N. J. (Cook, '68, p. 199, and map in portfolio).
  - Section from, to New York city, N. Y. (Cook and Smock, '74).
- **Morristown, N. J.** Black shale with coal near (Nason, '89, p. 28).
  - Boundary of Newark near (Cook, '68, p. 175, Cook, '89, p. 11).
  - Surface deposits on Newark rocks near (Cook, '89, p. 12).
  - Trap hill near (Cook, '68, p. 188. Nason, '89, p. 37).
  - Trap ridges near (Cook, 82, pp. 57-58).
- **Morrisville, N. C.** Marl near (Kerr, '75, p. 187).
- **Morrisville, Pa.** Analysis of conglomerate from (C. E. Hall, '81, pp. 24, 111).
  - Analysis of sandstone from (Genth, '81, p. 111).
- **Morrisville, Pa.** Boundary of the Newark near (C. E. Hall, '81, p. 20. Lea, '58, p. 92).
  - Section near (C. E. Hall, '81, p. 41).
  - Small seams of coal at (C. E. Hall, '81, p. 24).
- **MORTON, [—].** Cited on fossil plants from Massachusetts (E. Hitchcock, '35, p. 235).
- **Mortons mill, Va.** Coal mines near (W. B. Rogers, '39, p. 81).
- **Mountain View, N. J.** Cellular trap at (Cook, '82, p. 55).
- **Mount Airy, N. J.** Description of trap, contact metamorphism, etc., near (H. D. Rogers, '40, pp. 154-155).
  - Dip in shale near (Cook, '82, p. 26).
  - Dip near (Cook, '68, p. 197).
  - Trap outcrop at (Cook, '68, p. 192).
- **Mount Airy, Pa.** Description of trap dike near (Frazer, '80, p. 29).
  - Trap dikes at (Lesley, '85, p. lxiv).
- **Mount Airy, Va.** Dip at (W. B. Rogers, '39, p. 80).
- **Mount Carmel, Conn.** Brief account of (Whelpley, '45, pp. 62-64).
  - Brief account of trap near (E. Hitchcock, '23, vol. 6, p. 45).
  - Character of trap of (Percival, '42, p. 312).
  - Contact metamorphism near (Percival, '42, p. 437).
  - Copper associated with (Percival, '42, pp. 320-321).
  - Description of trap ridges near (Percival, '42, pp. 395, 400-404, 406).
  - Elevation of (J. D. Dana, '75*a*, p. 498).
  - Origin of form of (Whelpley, '45, p. 64).
  - Reference to trap dike at (Davis and Whittle, '89, p. 127).
  - Structure connected with (Percival, '42, p. 438).
  - Topographic form of trap ridge near (Percival, '42, p. 306).
- **Mount Holly, Pa.** Section from near, to near Mechanicsville (Frazer, '77, pp. 274-277, pl. op. p. 274).
- **Mount Holyoke, Mass.** Account of the trap rocks of (E. Hitchcock, '41, pp. 641-643).
  - Brief account of (E. Hitchcock, 18, pp. 105, 108. E. Hitchcock, '35, p. 414. E. Hitchcock, '43, p. 187).

Mount Holyoke, Mass.—Continued.
Brief account of columnar trap at (Hitchcock and Hitchcock, '67, p. 87).
Brief account of geology of (Eaton, '18, p. 34).
Brief account of trap of (E. Hitchcock, '23, vol. 6, pp. 45–46).
Brief reference to sandstone at (E. Hitchcock, '35, p. 215).
Chemical analysis of trap from (Hawes, '75).
Columnar trap on (E. Hitchcock, '35, p. 400).
Contact metamorphism on the north side of (E. Hitchcock, '41, p. 657).
Description of (E. Hitchcock, '41, pp. 241–246).
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Description of fossil plant from (E. Hitchcock, '43*b*, p. 295, pl. 13).
Description of scenery near (E. Hitchcock, '23, vol. 7, pp. 5–9).
Description of trap ridge connected with (Percival, '42, 368–370).
Dip and strike of rocks at (E. Hitchcock, '41, p. 448).
Dip of sandstone beneath trap at (E. Hitchcock, '41, p. 654).
Dips near (E. Hitchcock, '35, p. 417).
Discussion of the geological structure of (W. M. Davis, '86).
Early discovery of fossil footprints at (E. Hitchcock, '36, p. 309).
Fossil footprints at (E. Hitchcock, '58, pp. 50 et seq.).
Fossil footprints, locality for (E. Hitchcock, '48, p. 132).
Mention of (A. Smith, '32, pp. 224–227).
Note on sandstone beneath trap at (E. Hitchcock, '28, p. 18).
Notice of conglomerate on (Nash, '27, p. 246).
Origin and character of (Emerson, '87, pp. 19–20).
Origin of (J. D. Dana, '75*a*, p. 502. W. M. Davis, '82).
Origin of tufaceous conglomerate near (E. Hitchcock, '41, p. 527).
Reference to a fine conglomerate at (E. Hitchcock, '35, p. 215).
Reference to schistose sandstone beneath trap in (E. Hitchcock, '35, p. 35).
Reference to trap dikes of (Danberry, '39, p. 23).
Reference to volcanic origin of the trap rocks of (Cooper, '22, p. 239).
Trap conglomerate at (E. Hitchcock, '35, p. 215).
Section of (E. Hitchcock, 47*a*, p. 201).
Section showing junction of trap and sandstone at (E. Hitchcock, '41, p. 659).
Structure and lithological character of (Emerson, '86).
Topographic form of (Percival, '42, p. 304).
Tufaceous conglomerate on the east side of (E. Hitchcock, '41, p. 442).
Unusual dip of sandstone at (E. Hitchcock, '35, p. 223).
View from (E. Hitchcock, '41, pls. 2, 6).

Mount Horeb, N. J. Elevation of Second mountain at (Cook, '82, p. 52).
Mount Joy, Pa. Boundary of the Newark near (Frazer, '80, p. 37).
Mount Joy township, Pa. Report on the geology of (Frazer, '80, pp. 36–37).
Mount Mettawampe, Mass. Character of sandstone in (E. Hitchcock, '55, p. 226).
Mount Paul, N. J. Conglomerate of (Cook, '79, p. 19).
Dip in shale at (Cook, '82, p. 29).
Mount Pleasant, N. J. Character of the formation near (H. D. Rogers, '40, p. 131).
Dip in shale near (Cook, '82, p. 27).
Quarries of trap rock at, mention of (S. P. Merrill, '89, p. 435).
Mount Pleasant, Pa. Analysis of trap from (Genth, '81, p. 97).
Mount Pleasant iron mine, Pa. Boundary of the Newark near (H. D. Rogers, '41, p. 16, 39. H. D. Rogers, '58, vol. 2, p. 668).
Mount Prospect institute, N. J. Boundary of first mountain trap near (Cook, '68, p. 181).
Mount Rose, N. J. Copper ores near (Cook, '68, p. 679).
Dip in shale near (Cook, '82, p. 25, 26).
Dip near (Cook, '68, p. 197).
Elevation of (Cook, '68, p. 190).
Elevation of trap ridge at (Cook, '82, p. 60).
Trap boundary near (Cook, '68, p. 190).
Mount Sorrow, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 675).
Mount Toby, Mass. Brief account of sandstone and conglomerate near (E. Hitchcock, '35, p. 221).
Character of rocks at (E. Hitchcock, '41, p. 447).
Concerning the origin of the conglomerate of (E. Hitchcock, '35, p. 244).
Conglomerate in (E. Hitchcock, '35, pp. 214, 215. E. Hitchcock, '41, p. 442).
Description of (Emerson, '82. E. Hitchcock, '41, pp. 248–249. Percival, '42, p. 409).
Description of scenery near (E. Hitchcock, '23, vol. 7, p. 10).
Description of trap ridges near (E. Hitchcock, '41, p. 648. Percival, '42, pp. 409–410).
Dip of rocks on (E. Hitchcock, '35, p. 224).
Discussion concerning footprints found at (E. Hitchcock, '36, p. 334).
Estimated thickness of Newark system at (E. Hitchcock, '35, p. 224).
Mention of rock composing (Percival, '42, p. 450).
Note on conglomerate near (Nash, '27, p. 247).
Section of (Walling, '78, pl. op. p. 192).
Stratigraphy near (Walling, '78).
Trap between sandstone at (E. Hitchcock, '35, p. 416).
Trap dikes at (E. Hitchcock, '35, p. 224).
Trap interstratified with sandstone at (E. Hitchcock, '41, p. 654).
Trap ridges near (E. Hitchcock, '35, p. 409).
Mount Tom, Mass. Abnormal dip near (E. Hitchcock, '35, pp. 419–421).
Account of the trap rock of (E. Hitchcock, '41, pp. 641–643).

Mount Tom, Mass.—Continued.

Additional facts concerning a fossil form from (E. Hitchcock, '60).

An overflow trap sheet (W. M. Davis, '88, pp. 464–467).

Brief account of (E. Hitchcock, '18, pp. 105, 108. E. Hitchcock, '35, p. 414. E. Hitchcock, '43, p. 187).

Brief account of trap of (E. Hitchcock, '23, vol. 6, pp. 45–46).

Brief reference to sandstone at (E. Hitchcock, '35, p. 215).

Columnar trap on (E. Hitchcock, '35, p. 400).

Contact metamorphism on the east side of (E. Hitchcock, '41, p. 657).

Contact metamorphism on the east side of, description of (E. Hitchcock, '35, pp. 423–429).

Description of (E. Hitchcock, '41, pp. 246–247).

Description of geology near (W. M. Davis, '83, pp. 261–269).

Description of scenery near (E. Hitchcock, '23, vol. 7, p. 9).

Description of a section across the Connecticut valley at (E. Hitchcock, '55).

Description of trap ridge connected with (Percival, '42, pp. 368–370).

Description of trap ridges near (Percival, '42, pp. 389–393).

Description of trap tuff on the east side of (E. Hitchcock, '24, pp. 245–247).

Dip and strike of rocks at (E. Hitchcock, '41, p. 448).

Dip at (E. Hitchcock, jr., '55, p. 23).

Dip near (E. Hitchcock, '36, p. 308).

Dip of rocks beneath trap at (E. Hitchcock, '35, p. 223).

Dip of sandstone beneath trap at (E. Hitchcock, '41. p. 654).

Dips near (E. Hitchcock, '35, p. 417).

Elevation of (J. D. Dana, '75*a*, p. 498).

Fossil fern from (E. Hitchcock, '58, p. 6).

Fossil fern from, description of (E. Hitchcock, jr., '55).

Fossil footprints at (E. Hitchcock, '58, pp. 50 et seq.).

Fossil footprints found near (D. Marsh, '48, p. 272).

  Description of (E. Hitchcock, '36, pp. 317–325).

  Early discovery of (E. Hitchcock, '36, pp. 308–309).

  Localities of (E. Hitchcock, 41, p. 465).

  Locality for (E. Hitchcock, '48, p. 132).

  Reference to (Macfarlane, '79, p. 63).

Fossil shell from (E. Hitchcock, '58, p. 6).

  Description of a (E. Hitchcock, jr., '56).

Mention of (A. Smith, '32, p. 224).

Origin and character of (Emerson, '87, pp. 19–20).

Origin of, mentioned (J. D. Dana, '75*a*, p. 502).

Overflow, origin of (W. M. Davis, '82).

Section across Connecticut valley at (E. Hitchcock, '58, pl. 3).

Section from, to Wallingford, Conn. (W. M. Davis, '83, pp. 305–307, pl. 10).

Mount Tom, Mass.—Continued.

Section of (E. Hitchcock, '47*a*, p. 200. E. Hitchcock, jr., '55, p. 23).

Section of, after E. Hitchcock (W. M. Davis, '83, p. 281, pl. 9).

Section showing junction of trap and sandstone at (E. Hitchcock, '41, p. 656).

Section through (Walling, '78, pl. op. p. 192).

Thickness of sandstone east and west of (E. Hitchcock, jr., '55).

Topographic form of (Percival, '42, p. 304).

Trap conglomerate at (E. Hitchcock, '35, p. 215).

Tufaceous conglomerate on the east side of (E. Hitchcock, '41, p. 442).

Mount Top, Pa. Trap and iron ore from (C. E. Hall, '78, p. 31).

Mount Vernon, N. J. Boundary of Long hill trap near (Cook, '68, p. 187).

Boundary of the Newark near (Frazer, '80, p. 13).

Mount Warner, Mass. Description of (E. Hitchcock, '41, p. 249).

Dips near (Walling, '78, p. 192).

Mount Washington, N. J. Trap hill near (Cook, '68, p. 188).

Mud cracks at Pompton, N. J. (Cook, '68, p. 201).

Condition of deposition shown by (J. D. Dana, '75, p. 420).

In sandstone of Connecticut valley (E. Hitchcock, '58, pp. 169–170, pls. 39, 60).

(See also Sun cracks.)

Mulhockaway creek, N. J. Boundary of Newark along (Cook, '68, p. 175).

Murchison, N. C. Sketch showing outcrop of coal near (Chance, '85, p. 48).

Murchison coal mine, N. C. Quality of coal found at (Emmons, '52, p. 131).

MURCHISON, RODERICK IMPEY. **1843.**

Address delivered at the anniversary meeting of the Geological Society of London, on the 17th of February, 1843.

London, pp. 1-118.

Discusses the footprints of the Connecticut valley and the probable age of the rocks in which they occur, pp. 104–108.

MURCHISON [RODERICK IMPEY]. **1843a.**

[On the footprints of the Connecticut valley sandstone.]

In Am. Jour. Sci., vol. 45, pp. 187–188.

General remarks concerning the fossils in question.

MURPHY, H. S. Trap rock quarried by (Cook, '81, p. 63).

Murray harbor, P. E. I. Dip near (Dawson and Harrington, '71, p. 15).

Sternbergia from (Dawson and Harrington, '71, p. 46).

Musconetcong mountain, N. J. Boundary of Newark near (Cook, '68, p. 175).

Musselman's lower mine, Pa. Detailed account of (Frazer, '80, pp. 302–304).

Myersville, N. J. Bored well near (Ward, '79, p. 139).

Myriapods, fossil, description in Connecticut valley (E. Hitchcock, '58, pp. 147–166).

Myriapods, fossil—Continued.

Description of tracks of (E. Hitchcock, '65, pp. 17, 18).

Position of, in scheme of classification (E. Hitchcock, '58, p. 48).

NASH, ALANSON. 1827.

Notice of the lead mines and veins of Hampshire county, Mass., and of the geology and mineralogy of the region.

In Am. Jour. Sci., vol. 12, pp. 238–270, and map.

Contains a brief and very general description of the sedimentary rocks of the Connecticut valley with a discussion of their origin, pp. 246–247, and map.

[NASON, FRANK L.]. 1889.

The Triassic rocks, or the Red sandstone of New Jersey

In geological survey of New Jersey, annual report of the state geologist for the year 1888, pp. 16–48, pl. op. p. 42.

Records detailed observations on the Newark system in New Jersey. Discusses the presence of faults and the relation of the trap ridges to drainage lines.

[NASON, FRANK L.] 1889a.

Geological studies of the Triassic or Red sandstone and trap rock.

In New Jersey Geol. Surv. Rep. for 1889, pp. 66–72.

Discusses the source of trap pebble found in the Newark rocks of New Jersey.

[NASON, F. L.]. 188[illegible].

Artesian wells [in New Jersey].

In N. J. Geol. Surv., Ann. Rep. for 1889, pp. 82–89.

Contains the records of a number of wells bored in the Newark rocks of New Jersey.

NASON, FRANK L. 1890.

On the intrusive origin of the Watchung traps of New Jersey

In Geol. Soc. Am., Bull., vol. 1, pp. 562–563.

Describes a trap conglomerate near Montville, N. J., and discusses its origin.

NASON, F. L.

Cited on the intrusive nature of the trap sheets of New Jersey (Cook, '89, p. 14).

Cited on "pipe stem amygdaloids in the trap of Watchung mountain, N. J. (Davis and Whittle, '89, p. 134).

National Museum, Washington, D. C. Fossil footprints in (C. H. Hitchcock, '88, p. 123).

Neiman's mill, Pa. Contact metamorphism at (d'Invilliers, '83, p. 199).

Strike and dip of strata near (d'Invilliers, '83, p. 211).

Nell's copper mine, Pa. Detailed account of (Frazer, '80, pp. 301–302).

Nelson county, Va. Boundary of the Newark in (W. B. Rogers, '39, p. 74).

Brief account of sandstone in (W. B. Rogers, '36, pp. 81–82).

Neshanic, N. J. Course of trap ridge near (Nason, '89, p. 35).

Dip in red shale at (Cook, '82, p. 26).

Neshanic, N. J.—Continued.

Dip near (Cook, '68, p. 197).

Origin of trap rock near (Darton, '89, p. 138).

Section and description of trap sheet near (Darton, '90, p. 67).

Trap outcrops near (Darton, '90, p. 70).

NEUMAYER, M. 1885.

Die geographische Verbreitung der Jura-Formation.

In Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse, vol. 50, pp. 57–142, two maps and one plate.

Contains a brief review of the Jurassic formation in North America, based principally on the writings of J. Marcou, W. M. Gabb, C. King, and C. A. White, pp. 123–125. The maps give a general idea of the distribution of land and of climatic zones in the Jurassic period.

Neversink hills, Pa. Conglomerate from (d'Invilliers, '83, p. 380).

Neversink mountains, Pa. Conglomerate near (H. D. Rogers, '58, vol. 2, p. 681).

Section near (H. D. Rogers, '58, vol. 2, pp. 681–682).

Neversink station, Pa. Dip of shale near (d'Invilliers, '83, p. 221).

Unconformity near (d'Invilliers, '83, pp. 221–222).

New Amsterdam, N. J. Conglomerate at (Cook, '68, p. 210).

Newark. Objections to, as a group name (C. H. Hitchcock, '90).

Newark group. Name proposed (W. C. Redfield, '56, p. 181).

Newark system. Name proposed by W. C. Redfield (Russell, 89*a*).

Sections, pictorial review of the (W. M. Davis, '83, pp. 280–281, pls. 9–11).

Newark, N. J. Artesian well at (Cook, '79, pp. 126–127. Cook, '82, p. 142. Cook, '84, pp. 135–137).

Bored wells at (Cook, '85, pp. 114–115. Ward, '79, p. 150).

At, with analysis of water; record of strata passed through (Cook, '80, pp. 162–166).

Brief account of the geology near (Lyell, '45, vol. 1, p. 15).

Brief description of the brownstone quarries at (Russell, '78, p. 224).

Building stone at (Cook, 68, pp. 507–508).

Character of the rocks in quarries near (Nason, '89, p. 22).

Coal in thin seams at (Cook, '78, p. 110).

Dip at (Cook, '68, p. 196).

Dip in sandstone at (Cook, '79, p. 30. Cook, '82, p. 24. Lyell, '42).

Finding of the cast of a tree trunk at, mention of Edwards, '71).

Fossil plants found at, mention of (Newberry, '88, p. 13).

From, descriptions and figures of (Newberry, '88).

Newark, N. J.—Continued.
Plant remains at (Cook, '79, p. 27).
In sandstone near (Nason, '89, p. 28).
Quarries at (Cook, '79, p. 19. Cook, '81, pp. 47–49. Lyell, '42. Shaler, '84, pp. 141–144).
Raindrop impression from (Lyell, '51, pp. 238, 242–244).
Mention of (Lyell, '43, pp. 39–40. Lyell, '51. W. C. Redfield, '51*a*, pp. 73–74).
Notice of (W. C. Redfield, '42).
Sandstone exposed near, description of (H. D. Rogers, '40, p. 130).
Sandstone near, description of (Cook, '68, p. 209).
Sandstone quarries at (Cook, '79, p. 22. Shaler, '84, p. 141).
Section from, to Brooklyn heights, N. Y. (Cook, '68, p. 230).
Section near (Cook, '68, pp. 230, 231, 232, 324. Shaler, '84, p. 142).
Section of rocks exposed in quarry at (Finch, '26, pp. 209–211).
Trap rock in driven well at (Ward, '79, p. 150).
Wells bored in, records of (Nason, '89*b*).

Newark bay shore, N. J. Boundary of trap outcrop along (Cook, '68, p. 177).
Exposure of Newark sandstone and shale in (Britton, '81, p. 168).
Trap rock in (Cook, '68, p. 177).

Newark mountain, N. J. Description of (H. D. Rogers, '40, p. 146).
Section across, after H. D. Rogers (W. M. Davis, '83, p. 281, pl. 9).
Section across, after W. W. Mather (W. M. Davis, '83, p. 281, pl. 9).

New Baltimore, Va. Boundary of the Newark near (W. B. Rogers, '40, p. 63).

New Berlin, Pa. Trap dikes and dip of strata near (d'Invilliers, '83, p. 206).

NEWBERRY, J. S. **1866.**
Description of fossil plants from the Chinese coal-bearing beds. In geological researches in China, Mongolia, and Japan during the years 1862–1865, by Raphael Pumpelly. Appendix, pp. 119–123, pl. 9.
In Smith. Inst., Contrib. Knowl., vol. 15, pp. 1–143, pls. 1–9.
The fossils described in this paper are stated to be of Jurassic or Triassic age, and are compared with similar fossils from Abiquiu, N. Mex., Sonora, Mexico, and North Carolina.

NEWBERRY, J. S. **1870.**
[Remarks on the genesis of the Newark sandstones contiguous to the Palisades, N. J.]
In New York Lyc. Nat. Hist., Proc., vol. 1, 1870–1871, pp. 131, 133–134, 137.
Dissents from the hypothesis proposed by H. Wurtz, to the effect that the sandstones adjacent to the Palisades of the Hudson were derived from the disintegration of trap rock. Gives analysis of sandstone and trap.

NEWBERRY, J. S. **1873.**
[Remarks on copper ores in the Triassic sandstones of the United States.]
In New York Lyc. Nat. Hist., Proc., 2d ser., vol. 2?, 1874, pp. 16–17.
Describes the frequent occurrence of the ores of copper in the Triassic sandstones of New Mexico and Texas, and mentions that a similar impregnation of sandstone with copper is common in the Newark system.

NEWBERRY, J. S. **1876.**
Descriptions of the Carboniferous and Triassic fossils collected on the San Juan exploring expedition, under the command of Capt. J. N. Macomb, U. S. Engineers.
In report of the exploring expedition from Santa Fe, N. Mex., to the junction of the Grand and Green rivers of the great Colorado of the West, in 1859, under the command of Capt. J. N. Macomb, with geological report by Prof. J. S. Newberry, Washington (Engineer's Department, U. S. Army), 4to, pp. 135–148, pls. 1–8).
Some of the plants described are found also in the Newark.

NEWBERRY, J. S. **1878.**
Description of new fossil fishes from the Trias.
In New York Acad. Sci., Ann., vol. 1, 1879, pp. 127–128.
Abstract in Am. Jour. Sci., 3d ser., vol. 16, p. 149; and in Neues Jahrbuch, 1879, p. 110.
Describes the negus Diplurus, represented by *D. longicaudatus*, from Boonton, N. J.; and *Ptycholepis marshi*, from Durham, Conn. Concludes with brief remarks on the age of the system.

NEWBERRY, J. S. **1883.**
[Remark on the intrusive character of the trap of Bergen hill, N. J.]
In New York Acad. Sci., Trans., vol. 2, 1882–1883, p. 120.
Refers to an investigation by P. Schweitzer, demonstrating the difference between the trap of Bergen hill and the associated sandstone.

NEWBERRY, J. S. **1885.**
[Remarks on the geological position of the Triassic and Jurassic rocks of America.]
In New York Acad. Sci., Trans., vol. 5, 1885–1886.
States the geological position of the Newark system, as shown by the fossil plants and fossil fishes, pp. 17–20.

NEWBERRY, J. S. **1887.**
[Remark on the former extent of the Newark system.]
In New York Acad. Sci., Trans., vol. 7, p. 39.
States that the occurrence of Cretaceous strata resting on the crystalline rocks of Staten island, indicates the existence there during secondary times, of a region of separation between the Newark areas of Connecticut and New Jersey.

NEWBERRY, JOHN S. 1888.

Fossil fishes and fossil plants of the Triassic rocks of New Jersey and the Connecticut valley.

U. S. Geol. Surv., Monograph vol. 14, 4to, pp. i-xiv, 1-152, pls. 1-26, reviewed by J. Marcou, in Am. Geol., vol. 5, pp. 160-174.

Abstract in New York Acad. Sci., Trans., vol. 6, 1866-1887, pp. 124-128.

Notice in Am. Jour. Sci., 3d ser., vol. 37, pp. 77-78; and in Am. Geol., vol. 4, 187-188.

Gives a short account of the distribution and of the principal features of the Newark system; presents the views of previous authors as to its age; discusses its relations with similar terranes in the Rocky mountain region and in Europe, pp. 1-17.

Fishes: Reviews previous studies of the fossil fishes, and a list of those now known, pp. 19-23. Description of genera and species, principally from New Jersey and the Connecticut valley, pp. 24-76, illustrated by pls. 1-20.

Plants: Sketch of the flora with special reference to the fossil plants of the Connecticut valley and New York-Virginia (Palisade) areas, pp. 79-81. Description of genera and species, pp. 82-95, illustrated by pls. 21-26.

NEWBERRY, J. S. 1888a.

Triassic plants from Honduras.

In New York Acad. Sci., Trans., vol. 7, 1887-1888, pp. 113-115.

Preliminary publication of a paper subsequently printed under the title Rhætic plants from Honduras, in Am. Jour. Sci., 3d ser., vol. 36, pp. 342-351, pl. 8.

NEWBERRY, J. S. 1888b.

Rhætic plants from Honduras.

In Am. Jour. Sci., 3d ser., vol. 36, pp. 342-351, pls. 8.

Compares some of the fossils described with similar plants from the Newark.

NEWBERRY, J. S. 1890.

On *Dendrophycus triassicus.*

In Am. Nat., vol. 24, pp. 1068-1069.

A reply to J. F. James, in reference to the fossil mentioned, being of organic and not of inorganic origin.

NEWBERRY, J. S. Cited in the cause of the red color of the Newark sandstones (Russell, '82, p. 52).

Cited on fossil plant from Connecticut (Chapin, '91a).

Review of report on fossil fishes and fossil plants by (Marcou, '90).

Newberry, Pa. Contact metamorphism near (H. D. Rogers, '58, vol. 2, p. 688).

Trap dikes near (H. D. Rogers, '58, vol. 2, p. 688).

New bridge point, Pa. Dip of Newark rocks near (Lewis, '85, p. 452).

New Britain, Conn. Detailed study of the geological structure near (W. M. Davis, '89).

Mention of the occurrence of bitumen in (Percival, '42, p. 443).

New Britain, Conn.—Continued.

Trap ridges and faults near, map of (W. M. Davis, '89*c*, p. 424).

Trap ridges near, description of (Davis and Whittle, '89, p. 115. Percival, '42, pp. 373, 375, 376, 379, 381, 384-386).

New Brunswick. Brief account of the Newark system in (Bailey, Matthew and Ells, '80, pp. 2-23D and maps. Matthew, '63).

Brief note on contact of Newark and Carboniferous in (Bailey, '85).

Brief note on fossil wood from Gardner's creek (J. W. Dawson, '63).

Brief reference to the geology of (Russell, '78, p. 220).

Catalogue of mineral localities in (Marsh, '63).

Copper ore on Grand Manan, occurrence of (Chapman, '35).

Description and discussion of Newark rocks of (Dawson, '78).

Description of Grand Manan island (Verril, '78).

Geological map of (Bailey, '65. Dawson, '78, map. Logan, '65, map No. 1. Matthew, '65, map).

Geological sketch of (Credner, '65).

Newark on Grand Manan island (Matthew, '78, p. 339).

Newark rocks of, reference to (Dawson, '78, pp. 86-87).

Report on (Matthew, '65).

Summary concerning (Chapman, '78, p. 106).

Newark system in, former extent of (Dawson, '78, p. 108).

General remarks on (Dawson, '78, pp. 109-113).

Observations on the geology of (Bailey, '65).

Report on the geological survey of (Gesner, '39. Gesner, '40. Gesner, '41. Gesner, '42. Gesner, '43*a*).

Sections, Gardner's creek (Gesner, '41, p. 14).

Grand Manan island (Chapman, '72, op. p. 193).

Quaco head, near (Gesner, '40, p. 17).

New Brunswick, N. J. Abandoned quarries near (Cook, '81, p. 55).

Altered shale near (Cook, '83, p. 23).

Analysis of sandstone from (Cook, '68, p. 516).

Analysis of shale from (Cook, '68, pp. 384-385).

Artesian wells at (Cook, '85, pp. 112-113).

Baryta near (Cook, '68, p. 709).

Bearing of joints at (Cook, '68, p. 201).

Bored wells at (Cook, '82, p. 147. Ward, '79, pp. 132-133).

Brief account of the Newark system of (Dawson, '78, pp. 108-109).

Copper mine near, description of (H. D. Rogers, '40, p. 161).

Copper ore at (Cook, '71, pp. 55-56).

Copper ores near (Cook, '68, p. 678).

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Dip in sandstone near (Cook, '82, p. 25).

Dip in shale at (Cook, '79, p. 30).

Dip near (H. D. Rogers, '40, p. 128).

Minerals obtained near (Beck, '39).

New Brunswick, N. J.—Continued.
Native iron near (Cook, '83, p. 62).
Sandstone and shale exposed near, description of (H. D. Rogers, '40, p. 128).
Sandstone and shale near, exposure of (Russell, '78, p. 224).
Sandstone near, description of (Cook, '68, p. 208).
Sandstone quarry near (Cook, '79, p. 23).
Shale at, description of (Cook, '68, p. 212).
Soils at (Cook '78, pp. 24–25)
Trap and sandstone near, section of (W. M. Davis, '83, p. 309, pl. 11).
Trap between sandstone near (Cook, 68, pp. 20, 202–205).
Trap dike near (Cook, '68, p. 204).
Notice of (Cook, '87, p. 126).
Trap found near, in boring (H. D. Rogers, '40, pp. 148–149).
Trap near (Darton, '90, p. 39).
Description of (Darton, '90, p. 66).
Origin of (Darton, '89, p. 139).
Outcrops of (Cook, '82, p. 59).
Small outcrop of (Nason, '89, p. 36).
Trap ridge near, course of (Nason, '89, p. 35).
Reference to (Russell, '78, p. 241).
Trap rock of, brief reference to the nature of (Cooper, '22, p. 240).

New Chester, Pa. Trap dikes near (H. D. Rogers, '5o, vol. 2, p. 688).
Trap from (C. E. Hall, '78, p. 41).

New City, N. Y. Columnar traps at (Mather, '43, p. 282).
Conglomerate quarries near (Mather, '39, pp. 123–124).
Quarries near (Mather, '43, pp. 286–287).

New Durham, N. J. Boundary of trap outcrop at (Cook, '68, p. 177).
Building stone near, mention of (Cook, '81, p. 43).
Dip of sandstone at (Darton, '83).
Disintegrated sandstone at, description of an exposure of (Darton, '83).
Trap rock quarries at (Cook '79, p. 25).
West contact of trap sheet near (Darton, '90, p. 52).

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New Fairfield, Pa. Trap from (C. E. Hall, '78 p. 69).

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Newgate, Conn. Brief account of trap near (E. Hitchcock, '23, vol. 6, p. 49).
Sandstone associated with trap near (Percival, '42, p. 440).

Newgate mine, Conn. Rocks near (Percival, '42, pp. 316, 391).

Newgate mountain, Conn. Building stones near (Percival, '42, p. 439).
Mention of (Percival, '42, p. 445).
Trap ridges near description of (Percival, '42, pp. 389–391)
Topographic form of (Percival, '42, p. 308).

New Germantown, N. J. Analysis of conglomerate from (Cook, '68, p. 393)
Boundary of Newark near (Cook, '68, p. 175. H. D. Rogers, '40, pp. 16, 118).
Calcareous conglomerate near, detailed description of (H. D. Rogers, '40, pp. 137–138).
Conglomerate near (Cook, '65, p. 7. Cook, '68, p. 210).
Mention of (Nason, '90).
Conglomerate quarries near (Nason, '89, p. 39).
Dip in shale and conglomerate near (Cook, '82, p. 29).
Dip near (Cook, '68, p. 197. Cook, '68, p. 199).
Change of (H. D. Rogers, '40, p. 132).
Dip of variegated conglomerate near (H. D. Rogers, '36, p. 148).
Diverse dips near (Nason, '89, p. 18).
Section of trap and sandstone near (Darton, '90, p. 35).

New Germantown, N. J. Trap hill near, description of Cook, '68, p. 194).
Relation of (Nason, '89, p. 36).
Trap of, description (Darton, '90, pp. 36–37).
Variegated conglomerate near, description of H. D. Rogers, '36, p. 148).

New Germantown hill, N. J. Description of (Cook, '82, p. 65).

New Germantown mountain, N. J. Probable faults near (Nason, '89, p. 25).

New Haven, Conn. Artesian well bored at, record of (J. D. Dana, '83, p. 386).
Depth of (Hubbard, '89).
Dikes near, description of (W. M. Davis, '83, p. 268).
Dip of sandstone near (Whelpley, '45, pp. 61–62).
Faults near, evidence of (W. M. Davis, '88, pp. 469–470).
Garnets in trap near (E. S. Dana, '77).
Geology near, brief account of (Lyell, '45, vol. 1, p. 13).
Description of the (W. M. Davis, '83, pp. 267–269).
Geology of the vicinity of (Silliman, '14).
Map of trap ridges north of (J. D. Dana, '75, p. 418).
Native copper found near, mass of (Silliman, '18).
Sandstone quarries near (Shaler, '84, p. 127).
Sandstone range beginning near (Percival, '42, p. 433).
Scoraceous rocks near, mention of (J. D. Dana, '71*a*).

w Haven, Conn.—Continued.
- Section of trap dikes near (W. M. Davis, '83, pp. 305-307, pl. 10).
- South end of Newark area at (Percival, '42, p. 426).
- Topographic and geologic features near, description of the (J. D. Dana, '71, pp. 46-47).
- Topographic feature of the region about, brief account of (J. D. Dana, '75*a*, p. 170).
- Trap and sandstone near, relation of (Whelpley, '45, pp. 62-63).
- Trap dikes near (E. Hitchcock, '23, vol. 6, pp. 56, 57).
  - Reference to (Danberry, '39, p. 22).
- Trap hills near, general account of the (Silliman, '10, pp. 87-95).
- Trap outcrops near, critical study of (J. D. Dana, '91).
- Trap ridges near, account of the (Davis and Whittle, '89, pp. 105-106).
- Trap, character of (W. M. Davis, '89*b*, p. 25).
- Trap rock near (E. S. Dana, '75).
  - Brief account of (E. Hitchcock, '23, vol. 6, p. 50).
  - Mention of (S. P. Merrill, '84, p. 24).
  - Quarries of (Shaler, '84, p. 127).
  - Reference to the volcanic origin of (Cooper, '22, p. 239).
- West rock near, description of (Silliman, '20*a*, pp. 202-203).

New Haven, Pa. Boundary of the Newark near (Frazer, '80, pp. 15, 39).

New Holland, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).
- Conglomerate near (H. D. Rogers, '58, vol. 2, pp. 679-680).
- Trap dikes near (H. D. Rogers, '58, vol. 2, p. 687).

New Hope, Pa. Altered shales and sandstones at (H. D. Rogers, '48).
- Analysis of trap from (Genth, '81, pp. 94, 95, 96).
- Character of strata near (H. D. Rogers, '58, vol. 2, p. 673).
- Contact metamorphism at, brief account of (H. D. Rogers, '36, p. 162).
- Dikes near (H. D. Rogers, '58, vol. 2, p. 673).
- Dip in shale and sandstone at (Cook, '82, p. 26).
- Limestone at (Cook, '79, p. 32).
- Metamorphism near (H. D. Rogers, '58, vol. 2, pp. 673, 674).
- Strike near (H. D. Rogers, '58, vol. 2, p. 673).
- Section of dikes at, after H. D. Rogers (W. M. Davis, '83, p. 281, pl. 9).
- Silurian limestone in Triassic rocks at (Cook, '83, p. 26).
- Thickness of the Newark near (Frazer, '77*a*, p. 499).
- Trap, contact metamorphism, etc., near, description of (H. D. Rogers, '40, pp. 153-154).
- Trap dikes near, description of (H. D. Rogers, '58, vol. 2, p. 685).
- Trap hills near (Lesley, '85, p. xxix).

Newington, Conn. Sandstone quarries near (Shaler, '84, p. 127).

New Jersey. Age of the Newark rocks of (Marcou, '58, pp. 11, 13-16, 65. W. C. Redfield, '51).
  - Indicated by fossil fishes (W. C. Redfield, '43*a*. Redfield, '56, pp. 180-181).
  - Note in reference to (Dawson, '58).
  - Remarks on, (Newberry, '85. H. D. Rogers, '43*b*).
- Albite in sandstone from (J. D. Dana, '71*b*).
- Analysis of sandstone from (Schweitzer, '71).
  - Note on the (Wurtz, '72).
- Analysis of trap from (Hawes, '75).
- Arkose near Hoboken, possible origin of the (D. S. Martin, '83).
- Artesian wells in (Cook, '80. Ward, '79).
- Boundaries of Newark System in (Cook, '65. Cook, '73. Cook, '89, p. 11).
  - Briefly described (Nason, '89, p. 16).
- Building stone from, value of (Alger, '51).
  - Reference to (Russell, '80, p. 35).
- Calcite from Bergen hill (vom Rath, '77).
- Catalogue of specimens for the Centennial Exhibition (Cook, '76).
- Character of the Newark system in (Cook, '88).
- Columnar trap at Orange (Cook, '84, pp. 23-28).
  - A popular description of (Heilprin, '84).
  - Description of (Iddings, '86).
- Contact metamorphism at Rocky hill (J. D. Dana, '43, pp. 113-114).
- Copper mines of (Cook, '74, pp. 56-57).
- Copper mine at Flemington, N. J., report on a (E. and C. H. Hitchcock, '59).
- Copper ore in (Cook, '71, pp. 55-57. Cook, '73. Cook, '81, pp. 39-40).
  - Brief account of (Cook, '71, pp. 55, 57).
  - Detailed account of (H. D. Rogers, '40, pp. 158-165).
  - Mention of (Cook, '73, pp. 98-99).
- Datholite from Bergen hill (E. S. Dana, '72).
- Difference between the trap of Bergen hill and the associated sandstone (Newberry, '83).
- Dips in, general (J. D. Dana, '75, p. 419).
  - Hypothesis accounting for (Bradley, '76).
  - Reference to (D. S. Martin, '76, p. 120).
- Disintegrated sandstone at New Durham, description of an exposure of (Darton, '83).
- Former connection of the Newark sandstone in with the similar formation in the Connecticut valley (Bradley, '76, p. 289).
- Fossil fish, footprints, raindrop impressions, etc., at Pompton (W. C. Redfield, '43).
- Fossil fishes and footprints at Weehawken (Gratacap, '86).
- Fossil fishes and fossil plants from, description of (Newberry, '88).
- Fossil fishes from, description of (Egerton, '49. W. C. Redfield, '41).
  - Description of new, from Boonton (Newberry, '78).
  - List of (De Kay, '42).
  - Note on (W. C. Redfield, '39).
  - Note on the discovery of (Silliman, '39).
  - Record of the finding of, at Weehawken (Britton, '85).

New Jersey—Continued.
- Fossil fishes from, remarks on (Emmons, '57, p. 142. W. C. Redfield, '42).
- Fossil footprint, localities in, list of (C. H. Hitchcock, '88, pp. 122–123).
- Fossil footprint near Boonton, brief record of the finding of a (Russell, '79).
- Fossil footprints and plants from Milford, list of (see Eyerman, '89).
- Fossil footprints and raindrop impressions in, brief reference to (W. C. Redfield, '43*a*).
- Fossil footprints at Pompton, reference to the discovery of (E. Hitchcock, '43*a*, p. 255).
- Fossil footprints at Pompton and Princeton, brief statement concerning the occurrence of (Lea, '53, p. 185).
- Fossil footprints from, remarks on (Cope, '69, p. 242).
- Fossil footprints found near Milford, brief description of (Eyerman, '86).
- Fossil fucoid from Milford, description of a (Lewis, '80*b*).
- Fossil localities, artesian wells, etc. (Cook, '85).
- Fossil plants from, remarks on (Newberry, '85).
- Fossil raindrop impressions at Newark (W. C. Redfield, '42. Lyell, '51, pp. 238, 242–244).
  - From Pompton, description of (W. C. Redfield, '51*a*).
- Fossil reptile from (Cope, '68, p. 733).
- Fossil ripple-marks and raindrop impressions, brief account of, at Newark (Lyell, '43, pp. 39–40).
- Fossils from, description and illustration of (Newberry, '88).
- Geological map of (Cook, '86).
- Geological map of New York City and vicinity (D. S. Martin, '88).
- Geological maps of, small (Putnam, '86*b*, pp. 146, 150).
- Geology of Hudson county (Russell, '80).
- Geology of the Newark region in, general account of the (Pierce, '20).
- Hayesine from Bergen hill, description of (Darton, '82*a*).
- Hunterdon Copper Company's property, report on the (Dickeson, '59).
- Hydrocarbon in the trap of the first Newark mountain (Russell, '78*b*).
- Ichthyolites from Red sandstone of, mention of (W. C. Redfield, '42).
- Limestone outcrops along the northward border of the Newark rocks of, remark on a line of (Britton, '85*a*).
- List of railroad stations on the Newark in (Macfarlane, '79, pp. 89–92).
- Microscopical character of building stones from (G. P. Merrill, '84, pp. 24, 26, pl. 8).
- Minerals obtained near New Brunswick (Beck, '39).
- Minerals of Summerville copper mine (Torrey, '22).
- Minerals of the Weehawken tunnel (Chamberlin, '83. Darton, '82).
- Monoclinal dip of the Newark rocks of, a reference to the cause of the (W. M. Davis, '86).
- Native iron in trap from (Cook, '74, pp. 56–57).
- Native silver in, on the occurrence of (Darton, '85).
- Newark belt in defined (Fontaine, '79, pp. 2 31–33).
- Newark, a brief study of the stratigraph (Walling, '78, pp. 195–197).
- Newark in, description of the northwest bo dary of (Kitchell, '56, pp. 144, 145).
- Newark, an extended account of the (Co '82).
- Newark rocks of, on the former extent of D. Dana, '79. D. S. Martin, '83. D Martin, '85).
  - Former extent of the (Russell, '80*a*).
  - General description of (Cook, '79, pp. 35).
  - Separate origin of the (H. D. Rogers, '
  - In Hunterdon county (Cook, '64, pp. 6
- Newark system in, brief description of (C rad, '39. Emmons, '57, pp. 3, 7–9. Hitchcock, '56. Lyell, '54. Macfarla '79, p. 68. H. D. Rogers, '58, vol. 2, 759–765. Russell, '78, p. 223. Russell, p. 47).
- Newark system in, detailed account of (Cook, '68).
  - Discussion of the origin and former tent (J. D. Dana, '83).
- Newark system in, former extent of the (Br ton, '81, p. 169).
- Northern geological map of, scale, 2 mil to 1 inch (Cook and Smock, '74).
- Oölite at Franklin, Bergen county (Eaton, '30
- Origin of the material forming the Newar rocks of (Cook, '87, p. 127).
- Origin of the prevailing dip of the Newar sandstones and shales (Russell, '78, p. 229).
- Origin of the Red sandstones of (Newberry, '70).
- Palisade region of, general account of (Akerly, '20).
- Palisades trap, origin of (Wurtz, '70).
- Relations of the traps of (Darton, '90).
- Report on the geological survey of the State (H. D. Rogers, '36).
- Report on geology of (Cook, '83).
- Report on the Newark system in (Nason, '89).
- Report of progress in the study of the Newark rocks of (Cook, '87).
- Rogers, H. D., cited on the "variegated calcareous conglomerate" of (Lea, '53, p. 190).
- Sandstone quarries in (Cook, '81, pp. 42–64. Shaler, '84, pp. 141–144).
- Soils from shale and trap in (Cook, '78).
- Trap and sandstone along the Hudson, general description of (Cozzen, '43).
- Trap at Bergen hill (Credner, '65, pp. 392–394).
- Trap dikes and associated rocks of (Credner, 70).
- Trap from Paterson to Pompton, brief account of (Nuttall, '22, pp. 239–241).

ontinued.
e Palisades, on the composition of
Dana, '72).
›s of, brief account of (Russell, '78,
-242).
ions on (W. M. Davis, '82).
ion on the origin of (Darton, '89).
on the crescent form of certain
Rogers, '43c).
-shaped, of (Silliman, '44).
phic form of, remarks on the (Perci-
, p. 311).
in, brief account of (Emmons, '57,

ıark on the origin of the (T. S. Hunt

study of (Darton, '90).
', reference to the volcanic (Cooper
239, 243).
ɪuarries (G. P. Merrill, '89, pp. 435–
haler, '84, pp. 145–146).
s of, on the intrusive nature of the
c (Russell, '78a).
the (W. M. Davis, '82a).
ity between the Newark and the
ıc in (McGee, '88, p. 135).
ity of the Newark system and the
ous in (Cook and Smock, '78).
for New Jersey Oil Co. near New-
ıson, '89b).
tions. (Cook, '65, p. 21. Cook, '68,
folio. Cook, '68, p. 40. Cook, '80,
ɔiece. Cook and Smock, '78, p. 25.
'89, pp. 20, 22–24. H. D. Rogers,
H. D. Rogers, '40, pl. 1).
7. Mather (W. M. Davis, '83, p. 281,

Darton, '90, pp. 57, 58).
through (Credner, '65, pl. 13).
le station (Darton, '90, p. 24).
Mills (Cook, '68, p. 204).
; to Dean's pond (Cook, '68, p. 199,
ɔortfolio).
Passaic (Cook, '68, p. 199, and in
ɔ).
, showing junction of trap, with
tary rocks beneath (Russell, '80,

ɔne, near (Darton, '90, p. 69).
: to lake Ontario (J. Hall, '43).
arton, '90, p. 26).
, showing fault (Darton, '90, p. 23).
p mass (Darton, '90, p. 54).
ıp to Plainfield (Cook, '68, p. 199,
ortfolio).
, near (Cook, '81, p. 56).
(Darton, '90, p. 47).
› Newark system in (Davis and
39, pp. 388, 394).
to Boonton (Cook, '85, pl. op. p.

e, near. After G. H. Cook (W.
s, '83, p. 281, pl. 9).
Darton, '90, p. 35).
showing lower contact of trap
arton, '90, p. 31).

New Jersey, sections—Continued.
- Long Hill to Boundbrook (Cook, '68, p. 199, and in portfolio).
- Martin's dock (Cook, '68, p. 202. Darton, '90, p. 65. W. M. Davis, '83, p. 309, pl. 11).
- Morris hill (Cook, '68, p. 203).
- Morris Plains to Jersey City (Cook, '68, p. 199, and in portfolio).
- Neshanic Station, near (Darton, '90, p. 67).
- Newark (Cook, '81, pp. 48–49).
  - In quarry near (Shaler, '84, p. 142).
  - Rocks exposed in quarries at (Finch, '26, pp. 209–211).
- Newark and New York bays, across (Cook, '68' p. 231).
- Newark meadows (Cook, '68, p. 232).
- Newark mountains, across. After H. D. Rogers (W. M. Davis, '83, p. 281, pl. 9).
  - To Brooklyn heights, N. Y. (Cook, '68, pp. 230, 324).
- Palisades (Cook, '68, p. 200. Darton, '90. Emmons, '46, p. 200. Gray and Adams, '60, p. 242. Mather, '43, pl. 34).
  - After Cook (W. M. Davis, '83, p. 281, pl. 9).
  - After Mather (W. M. Davis, '83, p. 281, pl. 9).
  - From Jersey City to Fort Lee (Cozzens, '43, pl. 2).
  - Opposite New York (Cozzens, '43, pl. 3).
  - Slaughter's landing. After Emmons (W. M. Davis, '83, p. 281, pl. 9).
- Paterson (Darton, '90, p. 18. W. M. Davis, '83, p. 309, pl. 11. Shaler, 84, p. 143).
- Point Pleasant (W. M. Davis, '83, p. 309, pl. 11).
- Pompton lake, near (Darton, '90, p. 25).
- Rahway to Deal (Cook, '68, p. 242).
- Riegelsville to Trenton (Cook, '68, p. 199, and in portfolio).
- Rocky Hill (Darton, '90, p. 59).
- Sandy Hook to near Newburg, N. Y. (Akerly, '20).
- Sergeantsville, faulted beds near (Cook, '89, p. 14).
- Showing unconformity between the Newark system and the Cretaceous (Cook and Smock, '78, p. 171).
- Snake hill trap (Darton, '90, p. 55a).
- Somerville, brecciated below trap near (Darton, '90, p. 29).
- Sourland mountain (Darton, '90, pp. 91, 92).
- Titusville to Stockton (Darton, '90, p. 61).
- Union hill trap (Darton, '90, p. 53).
- Watchung mountains, across (Cook, '83, p. 166, and plate).
  - Trap sheets (Darton, '90).
- Weehawken. Palisade trap at. After I. C. Russell (W. M. Davis, '83, p. 281, pl. 9).
  - Showing junction of trap and sandstone at (W. M. Davis, '83, p. 309, pl. 11).
  - Trap and sandstone beneath (Darton, '90, p. 116, pl. 5. Russell, '80, p. 39).
- Westville, trap sheet near (Darton, '90, p. 66).
- Westwood and Hohokus, faulted beds between (Cook, '89, p. 14).

New Jersey and Connecticut valley. Sections, hypothetical, of, after I. C. Russell (W. M. Davis, '83, p. 281, pl. 9).

New Jersey and Connecticut valley—Continued.
  Sections, ideal, showing the opposite dips of the Newark of (Russell, '78, p. 230).
New Jersey to Connecticut valley. Section showing former connection of Newark areas (Le Conte, '82, p. 600).
New London, P. E. I. Analysis of limestone from (Dawson and Harrington, '71, p. 41).
  Discovery and geological age of *Bathygnathus borealis* from (Dawson, '54*a*).
  Discovery of *Bathygnathus borealis* at (Dawson, '53. Dawson and Harrington, '71, p. 16. Ells, '84, p. 19E. Owen, '76, p. 361).
  Fossil reptile from (Dawson, '78, p. 119).
  Triassic beds, so called, near (Bain and Dawson, '85, p. 155).
Newmarket, N. J. Dip at (Cook, '68, p. 197).
Newmarket, Va. Boundary of Newark near (Heinrich, '78, p. 236. W. B. Rogers, '40, p. 62).
New Prospect, Pa. Trap dike near (Lewis, '85, p. 448).
New Providence, N. J. Abandoned quarries near (Cook, '81, p. 55).
  Black shale, with plant remains near (Nason, '89, p. 28).
  Boundary of Second mountain trap near (Cook, '68, p. 184).
  Sandstone quarry near (Cook, '79, p. 23).
New Richmond bay, P. E. I. Trap (Ells, '84, p. 18E).
New Salem, Pa. Calcareous conglomerate from (C. E. Hall, '78, p. 68).
  Trap dikes near (Frazer, '76, p. 95).
Newton, N. J. Analysis of limestone from (Cook, '68, p. 516).
Newton, Pa. Sandstone quarries at (Shaler, '84, p. 157).
New Vernon, N. J. Altered shale near (H. D. Rogers, '40, p. 133).
  Dip in shale at (Cook, '82, p. 30. H. D. Rogers, '40, p. 133).
  Dip near (Cook, '68, p. 196. Cook, '68, p. 198. Cook, '68, p. 199).
  Diverse dips near (Nason, '89, p. 19).
  Fossil footprints from (Cook, '85, p. 95).
  Origin of trap near (Darton, '89, p. 137).
  Trap hill near (Cook, '68, p. 188).
  Trap outcrop at (Cook, '82, p. 19).
New Vernon trap ridge, N. J. Description of (Cook, '82, pp. 57–58).
New Vernon trap sheet, N. J. Description of (Darton, '90, pp. 34–35).
New York. Building stone of the Newark system in, brief report on the (J. Hall, '86, p. 195).
  Geological map of (Putnam, '86*a*).
  Geology of Rockland county, brief account of (Lincklaen, '61).
  Newark rocks in, brief description of (Conrad, '39. Emmons, '46. Macfarlane, '79, p. 68).
    Near Stony Point, brief note on (J. D. Dana, '80–'81, vol. 22, p. 113).
    Brief note on the presence of (De Kay, '42, p. 385).
    Brief reference to (J. Hall, '43).
New York—Continued.
  Newark sandstones in, brief theoretical consideration relating to mode of formation of (Mather, '45, p. 14).
  Newark region in, general account of the geology of (Pierce, '20).
  Newark rocks of Staten island, description of the (Britton, '81).
  Palisade region, general account of (Akerly, '20).
  Railroad stations on the Newark formation in, list of (Macfarlane, '79, pp. 67–88).
  Red sandstone and conglomerate of, an account of (Mather, '43, pp. 285–294).
  Report on the geology of (Cook, '79).
  Sandstone and trap of Richmond and Rockland counties, an account of the (Mather, '39).
  Sections of, after W. W. Mather (W. M. Davis, '83, p. 281, pl. 9).
    Haverstraw, near (Mather, 43, pl. 5).
    Rockland county (Mather, '43, pl. 45).
    Staten island (Cozzens, '43, pl. 4. Britton, '81, pl. 16).
    Verdrieije hook, near, sandstone with dike beneath trap (Mather, '43, pl. 5).
  Trap dikes of Staten island, brief reference to the (Chamberlin, '87).
  Trap ridges of, the topographic form of, remarks on (Percival, '42, p. 311).
  Trap rocks of, detailed study of, the (Darton, '90).
    An account of the (Mather, '43, pp. 278–283).
  Trap sandstone, etc., of Rockland and Richmond counties, report on (Mather, '43).
New York, southern, and New Jersey, northern. Sections across. After W. W. Mather (W. M. Davis, '83, p. 281, pl. 9).
Nictaure, N. S. Iron ores at (Alger, '27, pp. 229, 330).
Nockamixon cliffs, Pa. Brief account of (H. D. Rogers, '40, p. 124).
  Character of strata near (H. D. Rogers, '58, vol. 2, p. 674).
  Conglomerate of (Cook, '68, p. 209).
  Description of (H. D. Rogers, '36, p. 152).
  Dip in sandstone at (Cook, '82, p. 27).
Nockamixon swamp, Pa. Metamorphism near (H. D. Rogers, '58, vol. 2, p. 686).
Nolan's ferry, Va. Boundary of Newark near (Heinrich, '78, p. 235. W. B. Rogers, '40, p. 61).
Norristown, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).
  Character of strata at (H. D. Rogers, '58, vol. 2, p. 672).
  Dip of the Newark system at, remarks on (Frazer, '75*c*).
  Sandstone quarries at (Shaler, '84, p. 157).
  Unconformity at the base of the Newark near (Lesley, '83, p. 132).
North Belleville, N. J. Building stone near (Cook, '68, pp. 506–507).
  Dip in sandstone at (Cook, '82, p. 24).
  Fault at (Cook, '82, p. 16 and pl. 3).

North Belleville, N. J.—Continued.
- Quarries at (Shaler, '84, p. 141).
- Sandstone quarries at (Cook, '79, p. 22).

North Branch, N. J. Dip in shale near (Cook, '79, p. 30).

North Branford, Conn. Description of trap ridges near (Hovey, '89, p. 365. Percival, '42, p. 336).
- Topographic form of trap ridge near (Percival, '42, p. 303).

North Carolina. (Kerr, '75).
- Age of the coal-bearing rocks of (Stevens, '61).
  - As shown by specimens of lignite (W. B. Rogers, '55*a*).
  - Discussion of (Emmons, '57*b*, pp. 79–80. Lesquereux, '76, p. 283).
  - Indicated by fossil fishes (W. C. Redfield, '56, pp. 180–181).
  - Note in reference to (Dawson, '58).
  - Remarks on Newberry, '85).
- Analysis of coal from (Battle, '86).
- Analysis of water from bored well at Durham (Venable, '87).
- Brief account of Chatham series in (Emmons, '57, pp. 19–20).
- Coal fields of (Macfarlane, '77).
  - Brief account of (Daddow and Bannan, '66, pp. 403–406. Le Conte, '82, pp. 457–459).
  - Brief description of (McLenahan, '52. Patton, '88, pp. 23–25. H. D. Rogers, '58, vol. 2, p. 764. Williams, '85, p. 59).
  - Detailed report on (Chance, '85).
- Comparison of rocks of, with those of the Connecticut valley, New Jersey, etc. (Emmons, '57, pp. 14–16).
- Conglomerate at the base of the Newark, brief account of (Emmons, '57, pp. 19–21).
- Conglomerate in (Kerr, '75*a*).
- Dan river area, account of (Olmsted, '27).
- Deep river coal field, brief account of (Chance, '84. W. R. Johnson, '51*a*. Jackson, '56*a*. Lyell, '54, p. 12. Lyell, '66, p. 457).
  - Description of (W. R. Johnson, '50, pp. 161–166).
  - General account of in (Macfarlane, '77, pp. 516, 528).
  - Report on (Wilkes, '58).
- Deep river valley, special report on (Emmons, '57*a*).
- Depth of artesian well at Durham (Venable, '87).
- Dip of sandstone in the Chatham series (Emmons, '57, p. 22).
- Dip opposite, in Deep and Dan river, Newark areas of (Bradley, '76. Kerr, '75).
- Dip, prevailing, of the Newark in (W. B. Rogers, '42).
- Dips, general, in (J. D. Dana, '75, p. 419).
- Emmons, E., cited on fossil bird bone from (Mackie, '64).
- Former connection of the two Newark areas in (Bradley, '76, p. 289).
- Fossil fish from, remarks on (E. Emmons, '57, p. 142).

North Carolina—Continued.
- Fossil plants from, compared with the older Mesozoic of Virginia (Fontaine, '83, pp. 122–123).
  - Compared with others from China, Mexico, and New Mexico (Newberry, '66).
  - List of (Fontaine, '83, p. 101).
- Fossil reptiles from (Emmons, '57, pp. 145–147, pl. 8).
  - Description of (Cope, '69, pp. 10–11, 56–59).
  - Observations on (Cope, '70. Cope, '73).
- Fossil vertebrates from, synopsis of (Cope, '75).
- Fossils, associated with coal in (H. D. Rogers, '58, vol. 2, p. 764).
- Fossils, mammalian, from, description of (Osborn, '86. Osborn, '86*a*. Osborn, '87)
- Geological maps of (Willis, '86, pls. op. pp. 301, 302).
- Gold in Newark rocks, mention of the occurrence of (Mitchell, '27).
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- Iron ores of (Willis, '86, pp. 305–306).
- List of railroad stations on the Newark (Kerr, '79*a*).
- Mitchell cited on the trap rocks of (Lyell, '47, p. 273).
- Newark system in, condensed account of the (J. D. Dana, '75, pp. 405, 406).
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  - Observations on (Kerr, '75*a*).
- Older Mesozoic flora of, general remarks and conclusions on (Fontaine, '83, pp. 121–128).
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- Oölitic basin in, briefly described (H. D. Rogers, '56, p. 32).
- Outlines of the geology of (Mitchell, '42).
- Physiographical description of (Kerr, '79).
- Quarries of Newark sandstone in (Shaler, '84, pp. 181–182).
- Reference to the opposite dips and former connection of the two main Newark areas of (Russell. 78, pp. 252–253).
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- Report on the geology of (Emmons, '52. Kerr, '75. Olmstead, '24).
- Report on the Midland counties of (Emmons, '56).

North Carolina—Continued.
- Report on the mineralogy of (Genth and Kerr, '81, pp. 82–83).
- Report of progress on geology of (Kerr, '66).
- Review of E. Emmons's geological report on the Midland counties of (Dewey, '57).
- Sandstone in the gulf, thickness of (Emmons, '57, p. 22).
- Sandstone quarries of (G. P. Merrill, '89, pp. 455–456).

North Carolina, sections. (Emmons, '56, pp. 338–342. Emmons, '57, p. 152, and plate. Emmons, '57*b*, p. 76. Fontaine, '83, p. 100. Kerr, '79).
- Cape Fear and Deep rivers (W. R. Johnson, '51, map No. 2).
- Coal-bearing rocks (Emmons, '52, pp. 115–116).
- Dan river coal field (Emmons, '52, p. 144. Emmons, '56, pp. 255, 260. Emmons, '57, p. 12. Jones, '62, p. 89. Kerr, '75, map).
- Deep river coal field (Emmons, '52, pp. 120–125. Emmons, '56, pp. 238–239. Jones, '62, pp. 89–90. Kerr, '75, map. Wilkes, '58, p. 4).
- Dennis bridge near (W. R. Johnson, '51, p. 5).
- Dikes. After Emmons (W. M. Davis, '83, p. 281, pl. 9).
- Eagle bridge (Emmons, '52, p. 150).
- Egypt shaft (Chance, '85, p. 21. Emmons, '56, pp. 233–234. Emmons, '57, pp. 31–32. Jackson, '56*a*. Kerr, '75, p. 142. Wilkes, '58, pl. op. p. 6).
- Evans' mills (Emmons, '56, p. 231).
- Farmville (Chance, '85, pp. 22, 28–35).
- Gulf (Chance, '85, p. 41. Emmons, '57, p. 152, and plate).
- Leaksville (Emmons, '56, pp. 257–258).
- Madison, near (Emmons, '56, p. 259).
- Sewell's millstone quarries (W. R. Johnson, '51, map No. 5).
- Showing relation of Newark system in (Emmons, '57, p. 9).
- Taylor's, coal seams at (Chance, '85, p. 40).
- Wade's coal mine near Leaksville, coal-bearing shales at (Emmons, '52, p. 149).
- Statistical and descriptive account of (Anonymous, '69).
- Trap dikes in, decomposition of (Burbank, '73).
  - Mention of, in (Bradley, '76).
  - Brief account of, in (Emmons, '57, p. 150).
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Raleigh, pp. 1–136.
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Northfield, Conn. Trap dikes in (Frazer, '83, p. 220.)
- Trap ridges near (Percival, '42, p. 346).
  - Description of (Percival, '42, p. 337).

Northfield, Mass. Boundary of Newark near (E. Hitchcock, '58, p. 9).
- Coarse conglomerate in, reference to (C. H. Hitchcock, '77*a*, p. 446).
- Columnar trap near (E. Hitchcock, '23, vol. 6, pp. 53, 55).
- Limestone in, reference to (E. Hitchcock, '35, p. 218).
- Newark area at, north end of (Percival, '42, p. 426).
- Newark at, north terminus of (A. Smith, '32, p. 219).
- Newark rocks of, character and mode of formation of (Jackson, '41).
- Trap in, brief account of (E. Hitchcock, '23, vol. 6, p. 44).
- Trap near, brief account of (E. Hitchcock, '23, vol. 6, pp. 46, 49).
- Unconformity at base of Newark (Jackson, '56*b*, p. 184).

Northfield, N. J. Trap hill near (Cook, '68, pp. 185, 186).

Northford, Conn. Fetid limestone in, reference to (E. Hitchcock, '41, p. 444).
- Limestone near, description of (Percival, '42, p. 316).
- Trap ridges near, description of (Percival, '42, pp. 336, 342–343).
- Trap ridge near, topographic form of (Percival, '42, p. 304).

North Guilford, Conn. Conglomerate in (Percival, '42, p. 427).
- Trap ridges near, description of (Percival, '42, pp. 336, 338).

North Hamden, Conn. Contact metamorphism in (Percival, '42, p. 436).
- Contact phenomena near (Percival, '42, pp. 429–430).

Northampton, Mass. Artesian well at (Emerson, '87, p. 19).
- Brief account of a visit to (Lyell, '45, vol. 1, p. 252).
- Fossil footprints at (E. Hitchcock, '58, pp. 50 et seq.).
- Fossil footprints found at, remarks on (E. Hitchcock, '45*c*, pp. 62–65).
- Fossil footprints from, description of (E. Hitchcock, '36, pp. 317–325. E. Hitchcock, '41, pp. 478–501. E. Hitchcock, '48).
  - Special character of (E. Hitchcock, '41, p. 469).
- Fossil footprints in, localities of (E. Hitchcock, '41, p. 465).
- Plant impressions observed in (E. Hitchcock, '41, p. 450).
- Remarks on trap-tuff or tufaceous conglomerate at (E. Hitchcock, '44*e*, p. 7).

North Haven, Conn. Description of trap ridges near (Percival, '42, pp. 401–403).

North mountains, N. S. Contact of trap with sandstone beneath (Ells, '85, p. 7E).
- Description of (Dawson, '47, p. 55. Dawson, '78, p. 90. Gesner, '36, pp. 226–229. Jackson and Alger, '33, p. 220).
- Iron ore at (Harrington, '74, p. 207).
- Iron ores in, brief account (Alger, '27, p. 330).
- Rocks of (Gesner, '36, pp. 170, 224).

- **North mountains, N. S.**—Continued.
  - Sandstone beneath trap at (Gesner, '36, p. 72).
  - Trap of (Chapman, '78, p. 110, 111-112).
  - Trappean overflow (Chapman, '78, pp. 110, 111-113).
  - (See Blomidon.)
- **North Orange, Conn.** Description of trap dikes in Primary rocks near (Percival, '42, p. 414).
- **North Plainfield, N. J.** Shale between First and Second mountains near (H. D. Rogers, '40, p. 134).
- **North river, N. S.** Description of Newark rocks near (Ells, '85, p. 7E).
- **North Rockaway, N. J.** Dip in shale near (Cook, '82, p. 28).
- **North sugar leaf mountain, Mass.** Section of (Walling, '78, pl. op. p. 192).
- **North valley hill, Pa.** Newark rocks in contact with limestone area near (Lewis, '80*a*).
  - Trap dike near, description of (Frazer, '80, p. 30).
- **North Wilbraham, Mass.** Dip and strike of rocks in (E. Hitchcock, '41, p. 448).
- **Norwood coal mine, Va.** Notes on (Taylor, '35, p. 284).
- **Norwottock, Mass.** Section across Connecticut valley at (E. Hitchcock, '58, pl. 3).
  - Section through (Walling, '78, pl. op. p. 192).
  - Study of dips near (Walling, '78, p. 192).
- **Notch mountain, Conn.** Anterior trap ridges of (Davis and Whittle, '89, p. 109).
  - Small map of portion of (Davis and Whittle, '89, pl. 2).
- **Nott's coal mine, Va.** Analysis of coal from (Macfarlane, '77, p. 515).
- **Nottingham, Pa.** Trap dike near (Lewis, '85, p. 148).
- **Nowlan's, Va.** Boundary of the Newark near (W. B. Rogers, '39, p. 75).
- **Nova Scotia.** Age of the Newark rock in, remark on the (H. D. Rogers, '58, vol. 2, p. 693).
  - Age of the Newark system in, note in reference to the (Dawson, '58).
  - Amygdaloid minerals of (Jackson, '59*a*).
  - Amygdaloid on the east shore of the bay of Fundy, brief account of (Honeyman, '88).
  - Catalogue of mineral localities in (Marsh, '63).
  - Copper ore in (Howe, '69).
  - Dip of the Red sandstone in, brief account of (H. D. Rogers, '58, vol. 2, p. 761).
  - Geological map of, scale 3 miles to 1 inch (Dawson, '78, 1st ed., map).
  - Geological map of, scale 40 miles to 1 inch, (Gesner, '36).
  - Geological map of, with accompanying memoirs (Gesner, '43).
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    - Remarks on the (Gesner, '36).
  - Geology of, notes on (Alger, '27).
  - Gmelinite from, description of (Howe, '76).
  - Ideal section through the basin of Minas (See Hartt, '67, p. 243).
- **Nova Scotia**—Continued.
  - Iron ore of (Harrington, '74, pp. 207, 219).
  - Joints in trap of, remark on (Jackson, '41*a*).
  - Manganese in (Gilpin, '85).
  - Mineralogical paper relating to (Marsh, '67).
  - Mineralogy of (Howe, '69).
  - Mineralogy of the trap rocks of (Howe, '75).
  - Minerals found in, account of (Emmons, '36, p. 345-351).
  - Minerals of (Willimott, '84).
  - Native copper from the bay of Fundy, reference to (Gilpin, '77, p. 749).
  - Newark rocks in, brief account of (Chapman, '76, pp. 82-83. Dawson, '56, pp. 20-21. Hull, '87, p. 86. M'Kay, '66. H. D. Rogers, '58, vol. 2, p. 759-765).
    - Antigonish county (Honeyman, '67, pp. 108, 118).
    - Brief reference to (Macfarlane, '85, p. 56).
    - Description of (Ells, '84, p. 12E. Ells, '85, pp. 6-7E. Dawson, '78).
    - Former extent of (Dawson, '78, pp. 86-87).
    - Kings county, general account of (Honeyman, '79, pp. 27-28).
    - Mode of deposition of (Dawson, '78, p. 111).
    - Mode of formation of (Dawson, '78, p. 93).
    - Near Truro (Honeyman, '74, pp. 345-346).
    - On Five islands, Great village, etc. (Honeyman, '78).
    - Summary concerning (Chapman, '78, pp. 22, 106, 110-112).
  - Petrographic comparison of certain rocks in (Honeyman, 83).
  - Petrography of trap from (general account of (Honeyman, '85, pp. 122-124).
  - Section, basin of Minas, through (Hartt, '67, p. 243).
    - Blomidon, Lyell, '45, vol. 2, p. 172).
    - Blomidon and Horton, between (Dawson, '47, p. 56).
    - Cobequid bay to Cobequid mountains (Dawson, '78, pl. op. p. 125).
    - De Bert river, near (Dawson, '47, pl. 5).
    - Great village river, near (Dawson, '78, pl. op. p. 125).
    - Horton to cape Blomidon (Dawson, '78, pp. 90-94).
    - Minas basin, north shore of, after J. D. Dawson (W. M. Davis, '83, p. 281, pl. 9).
    - Partridge island (Dawson, '78, pl. op. p. 125).
    - Petite river, east of (Dawson, '52, p. 298).
    - Petite river, mouth of, showing unconformity at base of Newark (Dawson, '52, p. 399. Dawson, '78, p. 89).
    - Rocks of (Dawson, '78, pl. op. p. 20. Jackson and Alger, '33, map).
    - Showing unconformities in (J. W. Dawson, '52).
    - Swan creek, east of (Dawson, '78, p. 103).
    - Two islands, opposite (Dawson, '47, pl. 5).
  - Submerged ledge along bay of Fundy, shore of (Perley, '52, p. 159).
  - Trap in, brief account of (Beaumont, '34, pp. 247-248).
  - Trap of, brief account of (Chapman, '78, pp. 110, 111-112. Emmons, '36, p. 335).
    - Brief references to (Honeyman, '74*a*).

Nova Scotia—Continued.
Topographic form of, remarks on the (Percival, '42, pp. 311-312).

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Nishisakawick creek, N. J. Dip at (Cook, '68, p. 198).
Dip in shale at (Cook, '82, p. 27).

Nissely's mill, Pa. Boundary of the Newark near (Frazer, '80, p. 35).

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Cited on fossil fishes from the Richmond coal field, Va. (W. B. Rogers, '43, p. 300).
Cited on fossil plants from the Richmond coal field, Va. (Taylor, '48, p. 46).
Cited on the Richmond coal field, Va. (Taylor, '35, p. 289).

Nyack, N. Y. Dip and strike near (Mather, '43, p. 617).
Earth, charcoal, bones, etc., beneath Red sandstone (Akerly, '20, pp. 36, 59-60).
Quarries near (Mather, '43, p. 287).
Sandstone quarries near (Mather, '39, pp. 125-126).
Supposed fossil bone found near, mention of (Mitchill, '28, p. 9).
Trap near, outcrops of (Darton, '90, p. 38).
Trap rock near, brief account of (Mather, '39, p. 117).
Unconformity of trap and sandstone near *Darton*, '90, p. 48).

Oak island, N. S. Dip of sandstone on (Dawson, '78, p. 92).
Exposure of Newark sandstone at (Dawson, '47, p. 57).

Oakland, N. J. Trap hill near (Cook, '82, pp. 48, 49).
Trap ridge near, course of (Nason, '89, p. 34).

Oak mountain, Ga. Trap dikes in (Loughridge, '84, p. 279).

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Old Provost quarry, N. J. Dip in sandstone at (Cook, '82, p. 25).

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Cited on trap dikes in North Carolina (W. M. Davis, '83, p. 293).

Olmstead's mill, N. J. Dip of shale at (Cook, '79, p. 30).

O'Neil's quarry, N. J. Boundary of Second mountain trap at (Cook, '68, p. 184).

One-mile run, N. J. Dip at (Cook, '68, p. 196).

Onslow, N. S. Newark rocks near (Marsters, '90).

Orange, N. J. Bored well and spring near, with analysis of water (Cook, '85, pp. 118-122).
Bored well at (Cook, '84, pp. 132-135).
Boundary of First mountain trap near (Cook, '68, pp. 180, 181).
Columnar trap at (Cook, '84, pp. 23-28. Darton, '90, p. 24).
Columnar trap near, description of (Iddings, '86).
Popular description of (Heilprin, '84).

Orange, N. J.—Continued.

Description of quarries at (Cook, '81, pp. 50–51).

Dip in sandstone at (Cook, '82, p. 24).

Sandstone quarries near (Shaler, '84, pp. 142–143).

Sandstone quarry at (Cook, '79, p. 22).

Thickness of Watchung trap sheet near (Darton, '90, p. 22).

Trap rock quarries at (Cook, '79, p. 25. Cook, '81, p. 62).

Vesicular trap near (Darton, '90, p. 28).

Orange, Va. Boundaries of Newark near (Heinrich, '78, pp. 236–237. W. B. Rogers, '40, p. 62).

Orange county, N. C. An account of the Newark in (Mitchell, '42, pp. 130–134).

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Brief account of sandstone in (W. B. Rogers, '36, pp. 81, 82).

Character of conglomerate in (W. B. Rogers, '39, p. 72).

Newark area in (Heinrich, '78, pp. 236–237).

Orange mountain, N. J. Quarries of (Cook, '81, pp. 62–63).

Quarries of trap rock at, mention of (G. P. Merrill, '89, p. 436).

Sandstone quarries of (Shaler, '84, p. 142).

Ore Hill, N. C. Iron ore at (Kerr, '75, pp. 230–232).

Orwell bay, P. E. I. Description of fossil wood from (Dawson, '54).

Fucoids from (Dawson and Harrington, '71, p. 46).

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Conglomerate beneath (Cook, '68, p. 208)

Palisades, N. J.—Continued.

Contact metamorphism near, reference to (Cook, '87).

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Exposures of stratified rocks beneath (Russell, '80, p. 40).

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Origin of, discussed (Wurtz, '70).

Origin of the adjacent sandstone (Newberry, '70).

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Sandstone beneath (Cook, '82, p. 20).

Sandstone beneath trap at, reference to (Finch '26, p. 211. H. D. Rogers, '40, p. 145).

Sandstone quarries of (Shaler, '84, p. 143).

Section of (Cook, '68, p. 200).

Section of, after G. H. Cook (W. M. Davis, '83, p. 281, pl. 9).

Section of at Weehawken, after I. C. Russell (W. M. Davis, '83, p. 281, pl. 9).

Section of, opposite New York (Cozzens, '43, pl. 3).

Slickensides and faults in (Nason, '89, p. 26).

Trap at, thickness of (Cook, '82, p. 46).

Trap rock of (Cook, '79, p. 32).

Composition of (J. D. Dana, '72).

Observations on the stratification of the (Martin, B. N., '70).

Reference to the volcanic origin of the (Cooper, '22, p. 240).

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View of (Cook, '83, frontispiece).

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Contact metamorphism beneath (Mather, '43, p. 285).

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Section of dikes in sandstone under, after W. W. Mather (W. M. Davis, '83, p. 280, pl. 9).

Strike section of (Mather, '43, pl. 34).

Palisades, New York and New Jersey. Boundary of the Newark at base of (H. D. Rogers, '40, p. 117).

Brief account of (Macfarlane, '79, p. 68. D. S. Martin, '88, p. 9. Mitchill, '28, pp. 2–10).

Description of (Akerly, '20, pp. 27–28, 31–37, 57, 59–67).

Description of the geology of (W. M. Davis, '83, pp. 269–271).

Elevations on the (Akerly, '20, p. 28).

Palisades, New York and Virginia. Area, extent of (Emmons, '57, p. 3).

Palmer station, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 49).

- **Pannel's bridge, Va.** Boundary of Newark near (Heinrich, '78, p. 238. W. B. Rogers, '39, p. 75).
- **Pannil's mill, Va.** Dip at (W. B. Rogers, '39, p. 80).
- **Paoli, Pa.** Trap dike near (Lewis, '85, p. 445).
- **Papertown, Pa.** Structure near (Frazer, '77, p. 274).
- **Parcipany, N. J.** Character and dip of strata near (H. D. Rogers, '40, pp. 134–135).
- **Parsboro, N. S.** Rocks near (Jackson and Alger, '33, p. 280).
- **Partapique river, N. S.** Trap near (Dawson, '78, p. 100).
- **Partridge island, N. S.** Amygdaloid and tufa on (Dawson, '78, p. 106).
    - Amygdaloid beneath trap on (Dawson, '78, p. 106).
    - Contortion of shale at (Emmons, '36, p. 336).
    - Description of (Dawson, '78, pp. 105–106. Gesner, '36, pp. 242–249. Jackson and Alger, '33, pp. 268–272).
    - Dip of sandstone at (Dawson, '47, p. 54).
    - Exposures of Newark rocks at (Dawson, '47, p. 54).
    - Mention of (Marsters, '90).
    - Sandstone beneath trap at (Dawson, '47, p. 54).
    - Sandstone beneath trap on (Dawson, '78, p. 106).
    - Section on (Dawson, '78, pl. op. p. 125).
    - Specific gravity of trap rocks from (How, '75, vol. 1, p. 138).
    - Trap rock at (Dawson, '47, p. 54).
    - Trap above amygdaloid at (Gesner, '36, p. 244).
    - View of (Jackson and Alger, '33, pl. 3).
- **Paskack, N. J.** Dip in sandstone at (Cook, '82, p. 24).
- **Passaic, N. J.** Brief account of rocks near (Pierce, '20, p. 192).
    - Junction of trap and sandstone at (Darton, '90, p. 30).
    - Section from, to Boonton, N. J. (Cook, '68, p. 199, and map in portfolio).
    - Trap rock at, brief reference to the nature of (Cooper, '22, p. 240).
- **Passaic falls, N. J.** Columnar trap near (Cook, '68, pp. 202–203)
    - Conglomerate near (Cook, '79, p. 18).
    - Description of sandstone exposed near (H. D. Rogers, '40, p. 130).
    - Junction of trap and sandstone at (Russell, '78*a*).
    - Sketch of trap and sandstone at (W. M. Davis, '83, p. 309, pl. 11).
- **Paterson, N. J** Artesian well at (Cook, '79, p. 128).
    - Basal conglomerate beneath trap near (Darton, '89, p. 139).
    - Bored well at (Cook, '82, pp. 143–145).
    - Bored wells at, with analysis of water (Cook, '85, pp. 115–117).
    - Boundary of First mountain trap near (Cook, '68, pp. 180, 181, 182).
    - Boundary of Second mountain trap near (Cook, '68, p. 184).
    - Brief account of geology near (Nuttall, '22, pp. 239–241. Pierce, '20, pp. 189–192).

Paterson, N. J.—Continued.

- Brief account of the rock and mineral near (J. H. Hunt, '90).
- Building stone at (Cook, '68, pp. 505–506).
- Character of the rocks in quarries near (Nason, '89, p. 23).
- Columnar trap near (Cook, '68, pp. 202–203. Cook, '84, p. 27. Darton, '90, p. 24).
- Conglomerate at (Cook, '79, pp. 18, 31).
- Conglomerate quarries near (Nason, '89, p. 40).
- Contact metamorphism at (H. D. Rogers, '36, pp. 160–161. H. D. Rogers, '40, p. 146).
- Contact of trap and sandstone near (Cook, '82, p. 52).
- Contact of trap with sandstones beneath (H. D. Rogers, '36, p. 160).
- Dip at (Cook, '68, p. 196).
- Dip in sandstone at (Cook, '79, p. 30). Cook, '82, p. 24. H. D. Rogers, '40, p. 130).
- Dip near (Cook, '68, p. 199).
- Description of copper mines near (H. D. Rogers, '40, p. 160).
- Description of the geology near (W. M. Davis, '83, pp. 272–274)
- Exposure of supposed basal conglomerate near (Darton, '90, p. 17).
- Fault near (Cook, '83, p. 25).
- Faulted trap near, sketch of (W. M. Davis, '83, p. 309, pl. 11).
- Gap in trap ridge at (Cook, '82, p. 49).
- Junction of trap and sandstone at (Cook, '82, pp. 50–51. Darton, '90, p. 30).
- Notch in First mountain near (Nason, '89, p. 26).
- Plant remains in sandstone near (Nason, '89, p. 28).
- Quarries at (Cook, '79, p. 29).
    - Description of (Cook, '81, pp. 51–52).
    - Mention of (G. P. Merrill, '89, p. 436).
- Sandstone beneath trap at, reference to (H. D. Rogers, '40, p. 145).
- Sandstone exposed near, description of (H. D. Rogers, '40, p. 130).
- Sandstone near brief account of (H. D. Rogers, '40, p. 127).
    - Description of (Cook, '68, p. 209).
- Sandstone quarries at (Cook, '79, p. 21. Shaler, '84, p. 143).
- Section at (Shaler, '84, p. 143).
- Section of trap, sandstone, etc., near (Cook, '68, pp. 202–203).
- Trap hills near, brief reference to (H. D. Rogers, '36, p. 159).
- Trap outcrop at, description of (H. D. Rogers, '40, p. 146).
- Trap rock quarries at (Cook, '79, p. 25).
- Trap rock at, mention of (Mitchill, '28, p. 10).
- Vesicular trap near (Darton, '90, p. 28).

- **Pattenburg, N. J.** Boundary of Newark at (Cook, '68, p. 175. Cook, '89, p. 11. H. D. Rogers, '40, p. 118).
    - Conglomerate near (Cook, '79, p. 19. Cook, '82, p. 17).
    - Dip adjacent to limestone area near (Nason, '89, p. 19).

Pattenburg, N. J.—Continued.
  Folds near (Cook, '82, p. 17).
  Gneiss bordering the Newark system near (Nason, '89, p. 16).
  Limestone at (Cook, '82, p. 43).
PATTERSON, W. D. Stone quarry at Newark, N. J., description of (Cook, '81, p. 49).
PATTON, JACOB HARRIS. 1888.
  Natural resources of the United States. New York and London, pp i-xv, 1-523.
    Contains a brief general account of the Richmond, Farmville, Deep river, and Dan river coal fields, pp. 22-25.
Paug mountain, Conn. Description of (Percival, '42, p. 349).
  Fault near (W. M. Davis, '88, p. 473).
  Fossil fish near, mention of the occurrence of (Percival, '42, p. 446).
  Trap ridges near (Percival, '42, p. 348).
    Description of (Percival, '42, pp. 341, 350, 352, 370-371).
  Paving stones. (See trap.)
Peabody Museum, Yale College. Collection of fossil fishes in (Newberry, '88, p. 21).
Peach Bottom, Pa. Description of trap dike near (Frazer, '80, p. 31).
Peach Bottom ferry, Pa. Trap dikes at (Lesley, '85, p. lxiv).
Peapack, N. J. Boundary of Newark near (Cook, '68, p. 175. Cook, '89, p. 11. H. D. Rogers, '40, p. 118).
  Conglomerate near (Cook, '79, p. 19. Cook, '82, p. 21).
  Contact of Newark rocks and gneiss near (H. D. Rogers, '40, p. 16).
  Dip and character of sandstone near (H. D. Rogers, '40, p. 128).
  Dip in conglomerate near (Cook, '82, p. 29).
  Dip in shale near (Cook, '82, p. 29).
  Diverse dips near (Nason, '89, p. 18).
  Gneiss bordering the Newark system near (Nason, '89, p. 16).
Pearl knob, Conn. Description of (Percival, '42, p. 372).
Pebble bluff, N. J. Dip in conglomerate at (Cook, '82, p. 27).
  Dip of conglomerate at (Cook, '79, p. 29).
PECKITT, L. Analysis of iron ore by (d'Invilliers, '83, pp. 348-349).
Pelham, Mass. Description of trap dikes in Primary rocks in (Percival, '42, p. 426).
Peneplain. Explanation of the term (W. M. Davis, '89*c*, p. 430).
Pen Mar, Pennsylvania and Maryland. Trap dike near (Lewis, '85, p. 448).
Penn point, P. E. I. Sternbergia from (Dawson and Harrington, '71, p. 46).
Pennington, N. J. Dip near (Cook, '68, p. 197).
  Trap hills near, brief reference to (H. D. Rogers, '36, p. 159).
Pennington mountain, N. J. Description of (Cook, '68, p. 190. Cook, '82, p. 60).
  Detailed description of (Darton, '90, pp. 59-61).
  Origin of trap of (Darton, '89, p. 138).
Penn's neck, N. J. Boundary of Newark near (Cook, '68, p. 176).
Pennsylvania. Age of certain iron ores in (T. S. Hunt, '76, p. 320).
  Analysis of trap and sandstone from (Genth, '81).
  Annual report on, third (Rogers, '39, pp. 12, 17, 18-23).
  Annual report on geology of, fifth (H. D. Rogers, '41).
  Boundaries of the Newark system, briefly described (Lea, '58, p. 92).
  Brief account of having seen basalt in (T. P. Smith, '99).
  Catalogue of rocks from (C. E. Hall, '78).
  Cave near Port Kennedy, description of (Wheatley, '71).
  Conewago hills and Stony ridge, description of the (Gibson, '20).
  Copper ore at Bonnaughton, occurrence of (Frazer, '77*b*).
  County maps, brief explanation of (Lesley, '85).
  Dip, etc., in Lehigh county, observations on (C. E. Hall, '83).
  Dip of the Red sandstone in, brief account of the (H. D. Rogers, '58, vol. 2, p. 762).
  Dips in, general (J. D. Dana, '75, p. 419).
  Fault and trap dike near Yardleyville (Lewis, '82).
  Fossil bones and fossil plants at, finding of (Wheatley, '61*a*).
  Fossil fish scales at Yerkes station, record of the finding of (Leidy, '76).
  Fossil footprints and other fossils near Goldsboro, discovery of (Wanner, '89).
  Fossil footprints from, remarks on (Cope, '69, p. 242).
  Fossil reptiles from, description of (Cope, '69, pp. 25-26, 56, 59-61, 122A, 169-175, 232).
    Observations on (Cope, '73, p. 210. Cope, '70).
    Phœnixville, description of (Cope, '77).
  Fossil reptilian bones at upper Milford, on the finding of (Lea, '51, pp. 171-172).
  Fossil reptilian remains from, description of (Cope, '77).
    Phœnixville, a study of (Cope, '66).
  Fossil saurian from, description of (Lea, '53).
  Fossil shell from, description of (Conrad, '69).
  Fossils found at Phœnixville, account of (Lewis, '84).
    List of (Jones, '62, pp. 93-97).
  Fossils vertebrate from (Cope, '85).
    Description of (Cope, '87).
    Remarks on (Leidy, '57).
  Geological map of (Putnam, '86*c*, pl. op. p. 179).
    Adams county (Lesley and Frazer, '76).
    Cumberland county (Lesley, '80).
  Geology near West Chester, brief account of (Finch, '28).
  Geology of York county (Frazer, '75*c*. Frazer, '85).
  Iron ores and sandstones in the Newark system of, report on (d'Invilliers, '86).
  Iron ores near Dillsburg (Frazer, '76*d*).
  Isolated areas of older strata in the Newark of (Frazer, '77*c*).

Pennsylvania—Continued.

- Joints in trap dikes of, brief remark on (H. D. Rogers, '41*a*).
- Lehigh county, notes on (Lesley, '75).
- Lignite from (W. B. Rogers, '55).
- List of railroad stations on the Newark in (Macfarlane, '79, pp. 94-108).
- Lithographs of saurian bones from Phœnixville (Wheatley, '65).
- Manner in which the Newark rocks of, were deposited (Lesley, '64, pp. 438-480).
- Newark area in (Shaler, '84, p. 156).
- Newark area of Chester county (Frazer, '83).
- Newark ores in (Frazer, '77*c*).
- Newark rocks in, brief account of (E. Hitchcock, '56. Lyell, '54. Prime, '75).
- Newark system in, condensed account of (H. D. Rogers, '58, vol. 2, pp. 667-671).
- Newark rocks of, description of the (Frazer '82).
  - Extended account of (H. D. Rogers, '58).
  - In connection with other localities, brief discussion of (W. B. Rogers, '54).
- Newark rocks near Philadelphia, description of (C. E. Hall, '81).
  - Popular account of the (Lewis, '82*a*).
- Quarries of Newark limestone in (Shaler, '84, p. 156).
- Records of a bored well near Easton (Lesley, '91).
- Report on geology of Berks county (d'Invilliers, '83).
  - Chester county (Lesley, '83).
  - Lancaster county (Frazer, '80).
  - Montgomery and Bucks counties (C. E. Hall, '81).
  - Penn township (Frazer, '80, p. 38).
  - York and Adams counties (Frazer, '76).
  - York, Adams, Cumberland, and Franklin counties (Frazer, '77).
- Report on laboratory work (McCreath, '81).
- Sandstone quarries in (Shaler, '84, pp. 156-157).
- Second laboratory report (McCreath, '79).
- Sections, Adams county (Frazer, '77*a*).
  - Atland shaft, York county (Frazer, '77, pl. op. p. 232).
  - Beeler's crossroads, through (Frazer, '75, op. p. 94).
  - Bridgeport, west of, to Bryn Mawr (C. E. Hall, '81, in pocket).
  - Bridgeport to West Conshohocken (C. E. Hall, '81, in pocket).
  - Bridgetown to Bridgewater (C. E. Hall, '81, in pocket).
  - Bucks county (C. E. Hall, '81, p. 48).
  - Cashtown to Gettysburg (Frazer, '77, pp. 295-299, pl. op. p. 298).
  - Churchville to the Poquessing creek (C. E. Hall, '81, in pocket).
  - Cold point to Barren hill (C. E. Hall, '81, in pocket).
  - Cornwall, near, showing relation of the Newark and Primal slates (H. D. Rogers, '58, vol. 2, pp. 718-719).
  - Cornwall iron mines (Lesley and d'Invilliers, '85, pp. 498, 506).
  - Dillsburg, near (Frazer, '76*d*).

Pennsylvania—Continued.

  - Dillsburg to Beeler's crossroads, Adams county (Frazer, '77, pp. 265-273, pl. op. p. 264).
  - Dreshertown to Waverly heights (C. E. Hall, '81, in pocket).
  - Emigsville, through (Frazer, '76, op. p. 92).
  - Franklintown to near Wellsville (Frazer, '77, pp. 271-273, pl. op. p. 272).
  - Gettysburg, after P. Frazer; after H. D. Rogers (W. M. Davis, '83, p. 281, p. 9).
  - Gettysburg and Littlestown (Frazer, '77, pp. 299-304, pl. op. p. 304).
  - Harrisburg, near (Lesley, '64, p. 476).
  - Hockersville, near (d'Invilliers, '86, pp. 1566-1567).
  - Hummelstone brownstone quarry (d'Invilliers, '86, pp. 1564-1565).
  - Ideal of ancient surface on which the Newark was deposited (Lesley, '64, p. 476).
  - Jarrettown to Frankfort (C. E. Hall, '81, in pocket).
  - Jones's ore bank (H. D. Rogers, '58, vol. 1, p. 90).
  - Lancasterville to Ritterhousetown (C. E. Hall, '81, in pocket).
  - McCormic mine (Frazer, '77, pp. 215-217).
  - Monroe (H. D. Rogers, '58, vol. 2, p. 681).
  - Montgomery county, etc., near (Philadelphia (C. E. Hall, '81, in pocket).
  - Montgomery and Bucks counties (C. E. Hall, '81).
  - Morgan's mill to Holmesburg (C. E. Hall, '81, in pocket).
  - Morristown to Fairmount (C. E. Hall, '81, in pocket).
  - Morrisville (C. E. Hall, '81, p. 41).
  - Mount Holly to near Mechanicsville (Frazer, '77, pp. 274-277, pl. op. p. 274).
  - Neversink mountains, near (H. D. Rogers, '58, vol. 2, p. 681-682).
  - Newark rocks of (Frazer, '82, pp. 124-127. H. D. Rogers, '58, vol. 2, sheets 1 and 2, in portfolio. H. D. Rogers, '58, vol. 1, pp. 100, 102, 103, 160, 164).
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Petersburg, Pa.—Continued.
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  - Position and brief description of (Fontaine, '83, pp. 4–5).
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  - Copper ores near (Cook, '68, pp. 676, 677).
  - Dip in shale near (Cook, '79, p. 30; '82, p. 25).
  - Dip near (Cook, '68, p. 196).
  - Dip of shale near (Cook, '68, p. 677).
- **Plainfield, N. J.**—Continued.
  - Dip of strata near (H. D. Rogers, '40, p. 129).
  - Faults near (Cook, '68, p. 677).
  - Fossil fishes from, descriptions and figures of (Newberry, '88).
  - Fossil footprints near, notice of (Russell, '77, p. 415).
  - Fossil footprint locality, reference to, as a (C. H. Hitchcock, '88, p. 122).
  - Gap in First mountain near (Cook, '82, p. 50).
  - Lower contact of trap sheet near (Darton, 90, p. 29).
  - Metamorphosed shale near, exposure of (Russell, '80, p. 41).
  - Notch in First mountain near (Nason, '89, p. 26).
  - Ripple-marks, sun-cracks, raindrop impressions, and footprints at, mention of the occurrence of (Russell, '78, p. 225).
  - Sandstone near, description of (Cook, '68, p. 209).
  - Sandstone quarries near (Cook, '79, p. 23).
  - Section from, to Great swamp, N. J. (Cook, '68, p. 199, and map in portfolio).
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  - Trap near, on the intrusive nature of (Russell, '78*a*).
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  - Trap sheet near, thickness of (Darton, '90, p. 23).
  - Vesicular trap near (Darton, '90, p. 26).
  - View of (Cook, '82, pl. 1).
- **Plain's mills, N. J.** Boundary of First mountain trap near (Cook, '68, p. 181).
- **Plainville, N. J.** Dip near (Cook, '68, p. 197).
- **Plants, fossil.** Age of the Newark system indicated by (Agassiz, '51. Lea, '53, p. 193. Lesquereux, '76, p. 283).
  - Brief discussion of (W. B. Rogers, '54).
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  - Finding of, at Middletown, brief reference to (Silliman, '37).
  - Found in Connecticut, mention of (Percival, '42, pp. 442, 446).
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  - From Durham, description and figure of (Chapin, '91*a*).
  - From Southbury area (E. Hitchcock, '28, p. 228).
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Plants, fossil—Continued.

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    - Brief notice of (Warren, '54, p. 43).
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    - Position of, in reference to trap sheets (E. Hitchcock, '55, p. 226).
- From New Brunswick at Gardner's creek (Dawson, '63).
    - At Quaco Head, notice of (Gesner, '40, p. 15).
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    - At Belleville (Akerly, '20, p. 36).
    - Geological age indicated by (Newberry, '85).
    - Near Milford, description of (Lewis, '80b, Cook, '81, p. 64. Nason, '89, p. 27).
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    - Brief account of, in reference to age (Emmons, '57b, p. 79).
    - Description of (Emmons, '56, pp. 283–293. Emmons, '57, pp. 23–29, 34–38, 99–134, pls. 1, 2, 3).
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    - Deep river coal field, brief reference to (Emmons, '52, p. 142).
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- From Nova Scotia, etc. (Dawson, '78, p. 99).
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    - Near Gerrish mountain (Ells, '85, p. 7E).
- From Pennsylvania (Cook, '85, p. 55).
    - Brief account of (Lesquereux, '79).
    - Doylestown, remark on the finding of (Britton, '85).
    - Easton, mention of (Cook, '85, p. 95).
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- From Prince Edward island (Dawson, '78, p. 30. Dawson and Harrington, '71, pp. 45–46, pl. 3).
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    - Structure of (Lyell, '49, p. 285).
    - Undetermined (Fontaine, '83, pp. 90, 91, pls. 47, 48).
- Fucoid. from Prince Edward island (Dawson and Harrington, '71, p. 46).
- In the Newark of Virginia, description of (Fontaine, '83).
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- Remarks on (H. D. Rogers, '58, vol. 2, p. 695).
- Summary concerning (Miller, '79–'81, vol. 2, p. 242).

Pleasantdale, N. J. Plant remains in sandstone near (Nason, '89, p. 23).

Pleasant valley, N. J. Description of quarries at (Cook, '81, pp. 52–53).

- Dip in sandstone at (Cook, '82, p. 24).
- Quarries in (Cook, '81, pp. 52–53).

Pleasant Run station, N. J. Dip in shale near (Cook, '82, p. 29).

Pleasant View, Pa. Trap fragments near (Frazer, '80, p. 48).

Pleasantville, N. J. Description of quarries near (Cook, '81, pp. 59–60).

Pluckemin, N. J. Altered shale near (Cook, '83, p. 24).

- Boundary of First mountain trap near (Cook, '68, p. 180).
- Building stone near (Cook, '68, p. 509).
- Contact metamorphism near, reference to (Cook, '87, p. 125).
- Copper ores near (Cook, '68, pp. 676, 678. Cook, '83, pp. 164–165).
- Dip in sandstone near (Cook, '82, p. 29).
- Dip near (Cook, '68, p. 198. H. D. Rogers, '40, p. 128).
- Fossil fern from (Cook, '85, p. 95).
- Fossil fishes near (Cook, '79, p. 27).
- Limestone near (Cook, '68, p. 214).
- Plant remains in sandstone near (Nason, '89, p. 23).

Pluckemin, N. J.—Continued.
- Quarry near (Cook, '68, p. 183. Cook, '81, p. 55).
  - Character of the rocks in (Nason, '89, p. 23).
  - Description of (Cook, '81, p. 55).
- Sandstone near, description of (Cook, '68, p. 209).
- Sandstone quarry near (Cook, '79, p. 23).
- Trap hills near, brief reference to (H. D. Rogers, '36, p. 159).
- Trap near, vesicular (Darton, '90, p. 28).
- Trap ridge near, course of (Nason, '89, p. 34).
  - End of (Cook, '82, p. 49).
- Section of trap and sandstone near (Darton, '90, p. 35).

Plymouth, Pa. Boundaries of the Newark in (C. E. Hall, '81, pp. 72–73).
- Boundary of the Newark near (Lesley, '85, p. lxxxi).

Plymouth township, Pa. Report on the geology of (C. E. Hall, '81, pp. 72–74).

Poet's seat, Mass. Description of the geology of (W. M. Davis, '83, p. 259).

Point of Rocks, Md. Brief account of rocks near (Ducatel, '37, p. 36).
- Conglomerate near, description of (Fontaine, '79, p. 32).
- Potomac marble at (Shaler, '84, p. 177, pl. 46).
- Potomac marble at, mention of (Uhler, '79, p. 176).
- Potomac marble from, illustration of (Shaler, '84, pl. 46).

Point Pleasant, N. J. Altered shale near (Cook, '68, p. 214).
- Analysis of trap from (Cook, '68, p. 216).
- Bearing of joints near (Cook, '68, p. 201).
- Contact metamorphism at (Cook, '68, p. 192).
- Description of the geology near (W. M. Davis, '83, pp. 277, 278).
- Dip near (Cook, '68, pp. 197, 198).
- Dip in altered shale at (Cook, '79, p. 29. Cook, '82, p. 27).
- Dip in shale near (Cook, '82, p. 27).
- Indurated shale at (Cook, '82, p. 63).
- Origin of trap rock near (Darton, '89, p. 138).
- Section of trap, slate and shale near (W. M. Davis, '83, p. 309, pl. 11).
- Trap outcrop near (Cook, '68, p. 192. Cook, '82, p. 63).
- Trap outcrops near, description of (Darton, '90, p. 68).
- Trap, position of (Nason, '89, p. 36).

Pompton, N. J. Boundaries of the Newark near (Cook, '89, p. 11. H. D. Rogers, '40, p. 118).
- Brief account of geology near (Nuttall, '22, pp. 239–241).
- Building stone at (Cook, '68, pp. 504–505).
- Conglomerate at (Cook, '65, p. 7. Cook, '68, p. 212. Cook, '82, p. 40).
  - Character and origin of (Russell, '78, p. 253).
  - Occurrence of (Lea, '53, p. 190).
  - Reference to (Russell, '78, p. 232, 233).
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- Conglomerate near, description of (Kitchell, '56, pp. 144, 145).
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- Contact of Newark rocks and gneiss near (H. D. Rogers, '40, p. 16).
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- Dip of sandstone at (Cook, '79, p. 30).
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  - List of (De Kay, '42).
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- Sandstone outcrops near, description of (H. D. Rogers, '36, p. 152).
- Sandstone quarries near (Cook, '79, p. 22).
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- Trap conglomerate near, mention of (Nason, '90).
- Trap hills near, brief reference to (H. D. Rogers, '36, p. 159).
  - Description of (Cook, '68, p. 185).
- Trap ridge near, course of (Cook, '82, pp. 54–55).
- Trap sheet near, lower contact of (Darton, '90, p. 34).
  - Thickness of (Darton, '90, p. 33).
- Variegated conglomerate at, description of (H. D. Rogers, '36, p. 149).

Pompton furnace, N. J. Boundary of Newark at (Cook, '68, p. 175).
- Conglomerate at (Cook, '82, p. 21).
- Conglomerate quarries near (Nason, '89, p. 40).
- Dip in conglomerate at (Cook, '82, p. 30).
- Dip near (Cook, '68, p. 199).
- Fossil fishes found near (Nason, '89, p. 28).

Pompton furnace, N. J.—Continued.

Trap hill near, description of (Cook, '68, p. 185. Cook, '82, pp. 54–55).

Trap ridge near, course of (Nason, '89, p. 34).

Pompton lake, N. J. Section of trap sheets near (Darton, '90, p. 25).

Vesicular trap near (Darton, '90, p. 28).

Pompton plains, N. J. Boundary of Newark near (Cook, '68, p. 175).

Course of trap ridge near (Cook, '82, pp. 55–56).

Pond and Toket mountains, Conn. Bird's-eye view of (W. M. Davis, '88, p. 480).

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Pond mountain, Conn. Description of (Davis and Whittle, '89, pp. 110–111)

Discussion of the geological structure near (W. M. Davis, '86, pp. 345–346).

Evidence of faults in (W. M. Davis, '88, pp. 469–470).

Formed by overflow trap sheets (W. M. Davis, '88, pp. 464, 465).

Sketch map of (W. M. Davis, '88, p. 479).

Study of the structure of (W. M. Davis, '88).

Pond mountain, Va. Boundary of Newark near (Heinrich, '78, p. 235).

Pond ridge, Conn. Topographic form of (Percival, '42, p. 303).

Trap dikes near, description of (Percival, '42, pp. 420, 421).

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Trap rock of, structure of (Percival, '42, p. 314).

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[Note on the trap rocks of the Connecticut valley.]

In Am. Jour. Sci., vol. 4, pp. 241–242.

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Sandstone at, microscopical character of (G. P. Merrill, '84, p. 26, pl. 13).

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Fossil crustaceans found near (Nason, '89, p. 30).

Gray sandstone near, typical localities of (Nason, '89, p. 24).

Plant remains in sandstone near (Nason, '89, p. 27).

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Coal at, the occurrence of (Lea, '53, p. 193).
Coal near (W. B. Rogers, '39, p. 81).

Prince Edward island. Absence of Trias on, general (Ells, '84, pp. 11E-19E).
Age of the Newark system in, note in reference to the (Dawson, '58).
Age of the newer sandstones on (Dawson, '74).
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Bathygnathus borealis from (Owen, '76, p. 361).
Description of (Leidy, '54).

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On the discovery and geological age of (Dawson, '54*a*).
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Newark system in, brief account of the (Hull, '87, p. 86).
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Permian age of the younger sandstones on (Dawson, '75).
Physical geography of (Dawson, '72*a*).
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Rocks of (Dawson, '78, p. 111. Dawson, '78*a*, pp. 29, 31).
Separation of Trias and Carboniferous on (Dawson, '78*a*, p. 29).
Unconformity on (Bain, '87).

Prince Edward island, sections (Bain. '87).
Across (Dawson, '78, p. 31).
Bunbury island (Dawson and Harrington, '71, p. 20).
Campbellton to cape Tryon (Dawson and Harrington, '71, pl. —).
Cape Egmont (Dawson and Harrington, '71, p. 20).
Cape Kildare (Dawson and Harrington, '71, pp. 20-21).
Darnley, near (Dawson and Harrington, '71, pp. 18, 19).
Gallas point, through (Dawson and Harrington, '71, pl. —).

Prince Edward island, sections—Continued.
Indian point (Dawson and Harrington, '71, pp. 17-18).
Large curtain (Dawson and Harrington, '71, p. 20).
Orwell bay (Dawson, '78*a*, pp. 29, 31).
Summerside, near (Dawson and Harrington, '71, pp. 17-18).
Tea hill to Belfast (Dawson and Harrington, '71, pl. —).

Prince Edward Newark belt, Va. Defined (Fontaine, '79, p. 26).

Princeton, N. J. Analysis of soil from near (Cook, '78, pp. 37, 40).
Black shales near (Nason, 89, p. 31).
Building stone near (Cook, '68, p. 510).
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Dip near (Cook, '68, p. 196).
Footprints at, brief statement concerning the occurrence of (Lea, '53, p. 185).
Quarries near, description of (Cook, '81, p. 55).
Quarry at (Cook, '81, p. 55).
Reference to rocks near (Finch, '26, pp. 209-211).
Sandstone near, description of (Cook, '68, pp. 206, 209).
Sandstone outcrop near (H. D. Rogers, '40, p. 123).
Sandstone quarries at (Shaler, '84, p. 144).
Sandstone quarry near (Cook, '79, p. 24).
Sandstone strata near, description of (H. D. Rogers, '40, p. 126).
Shale near, exposure of (Nason, 89, p. 17).
Trap outcrops at (Cook, '82, p. 60).
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PUTNAM, BAYARD F. 1886a.
Notes on the samples of iron ore collected in New York.
In report on the mining industries of the United States, etc.
By Raphael Pumpelly, in Tenth Census of the United States, 4to, vol. 15, pp. 99-144, and 3 plates.
Contains a geological map of New York, showing area occupied by the Newark, and a map of Staten island, showing areas of trap rock and sandstone, p. 123.

PUTNAM, BAYARD F. 1886b.
Notes on the samples of iron ore collected in New Jersey.

PUTNAM, BAYARD F.—Continued.
In report of the mining industries of the United States, etc.
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Brief account of the geology near (Bailey, '65, p. 12. Chapman, '78, p. 106. Matthew, '65, p. 123. Whittle, '91).
Character of rocks at (Matthew, '65, pp. 123-124).
Dip of Newark rocks at (Matthew, '65, p. 124).
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Unconformity at (Matthew, '65, p. 125).

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Dip at (Dawson, '78, p. 108).
Dip of sandstone at (Emmons, '36, p. 344).
Description and age of rocks at (Credner, '65).
Description of (Gesner, '40, pp. 13-23).
Fossil wood at (Dawson, '78, p. 108).
Intrusive trap at (Bailey, Matthew, and Ells, '80, p. 23D).
Manganese near (Gesner, '40, pp. 17-18).
Map of Newark at (Matthew, '63, p. 248).
Observations made at (Emmons, '36, p. 344).
Position of (Bailey, Matthew, and Ells, '80, map No. 1 S. E., accompanying).
Rocks of (Bailey, '72, p. 217, 218. Bailey, Matthew, and Ells, '80, pp. 21-22D. Dawson, '78, p. 108. Gesner, '41, p. 14).
Section near (Gesner, '40, pp. 13-23).
Thickness of Newark rocks at (Dawson, '78, p. 108).
Trap rock at (Bailey, Mathews and Ells, '80).
Unconformity at base of Newark at (Emmons, '36, p. 344).

Quakertown, Pa. Analysis of trap from (Genth, '81, pp. 97-98).

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In New Jersey (Cook, '68, pp. 504-512).
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Near Trenton, N. J. (H. D. Rogers, '40, pp. 120-121).
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Quonipaug mountain, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 339, 361, 422–423).

Raccoon coal pits, Clover hill, Va. Plan and section of (Clifford, '87, pl. 2).

Raccoon Ford, Va. Boundary of Newark near (Heinrich, '78, p. 236. W. B. Rogers, '40, p. 61).

Rahway, N. J. Obscurity of exposures near (H. D. Rogers, '40, p. 129).

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In Massachusetts. Description of (E. Hitchcock, '41, pp. 501–503, pl. 49. E. Hitchcock, '43*a*, p. 262).

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Pompton (Cook, '68, p. 201. E. Hitchcock, '43*a*, p. 255. Lyell, '51. W. C. Redfield, '43. W. C. Redfield, '51*a*).

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Observations on recent (E. Hitchcock, '43*a*, p. 262).

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Physical conditions shown by (J. D. Dana, '75, p. 420).

Recent photographs of (Deane, '61, p. 59, pl. 45).

Referred to the bursting of bubbles (Desor, '51*a*).

Similarity of, to pits made by the breaking of air bubbles (Desor and Whitney, '59).

Suggested explanation of (H. D. Rogers, '55).

Raleigh, N. C. Boundary of Newark area near (W. R. Johnson, '51, p. 4).

Breadth of the Newark area west of (Emmons, '56, p. 241. Olmstead, '24, p. 12. Wilkes, '58, p. 2).

Brief account of Newark rocks near (Olmstead, '20).

Brief account of geology west of (McLenahan, '52, p. 170)

Ramapo, N. J. Conglomerate cemented with red shale (Nason, '89, p. 21).

Description of calcareous conglomerate near H. D. Rogers, '36, p. 149. (H. D. Rogers, '40, pp. 136–137.)

Ramapo, N. J.—Continued.

Mention of a fossil fish from (De Kay, '42, p. 385).

Trap rocks in (Mather, '43, p. 282).

Ramapo mountain, N. J. Gneiss bordering the Newark system near (Nason, '89, p. 16).

Ramapo valley, N. J. Borings for oil in (Cook, '68, p. 696).

Boundary of Newark in (Cook, '68, p. 175).

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Randolph's coal mine, Va. Analysis of coal from (Macfarlane, '77, p. 515. Williams, '83, p. 82).

Notes on (Taylor, '35, p. 284).

Rapho township, Pa. Report on the geology of (Frazer, '80, pp. 37–38).

Raritan, N. J. Dip near (Cook, '68, p. 198).

Raritan copper mine, N. J. Description of (Cook, '68, p. 679).

Dikes of trap in (Cook, '68, p. 204).

Raritan valley, N. J. Dip of sandstone in (Cook, '83, p, 26).

Rattlesnake hill, Pa. Trap dike (d'Invilliers, '83, pp. 200, 201).

Rattlesnake mountain, Conn. Description of (Percival, '42, p. 374).

Raudenbush mine, Pa. Detailed account of (d'Invilliers, '83, pp. 342–343).

Raven Rock, N. J. Building stone near (Cook, '68, p. 512).

Dip at (Cook, '68, p. 198).

Dip in indurated shale at (Cook, '82, p. 27)

Dip of altered shale at (Cook, '79, p. 29).

Sandstone quarries at (Cook, '79, p. 25).

RAYMOND, R. W. **1883.**

The natural coke of Chesterfield county, Va.

In Am. Inst. Mining Eng., Trans., vol. 2, pp. 446–450).

Reprinted in The Virginias, vol. 4, pp. 145–146; see, also, The Virginias, vol. 4, p. 164.

Describes the occurrence, illustrated by a section, of Carbonite [natural coke] near Midlothian, Va., and gives analysis of the material mentioned.

RAYMOND, R. W. Cited on natural coke in the Richmond coal field, Va. (Clifford, '87, p. 13).

Cited on the origin of the natural coke of the Richmond coal field, Va. (Hotchkiss, '83).

Reading, Pa. Boundary of the Newark near (d'Invilliers, '83, p. 198. Lea, '58, p. 92. H. D. Rogers, '58, vol. 2, p. 668).

Conglomerate near (Lea, '53, p. 190. H. D. Rogers, '39, p. 19. H. D. Rogers, '58, vol. 2, p. 681).

Dip of conglomerate near (d'Invilliers, '83, p. 221).

Exception in the prevailing dip of the Newark near (Lesley, '83, p. 182).

Sandstone quarries near (Shaler, '84, p. 157).

Trap dike near (d'Invilliers, '83, pp. 304, 380. H. D. Rogers, '58, vol. 2, p. 686).

Reamstown, Pa. Boundary of the Newark near (Fraser, '80, p. 43. H. D. Rogers, '58, vol. 2, p. 668).

REDFIELD, JOHN HOWARD. 1836.

Fossil fishes of Connecticut and Massachusetts, with a notice of an undescribed genus.

In New York Lyc. Nat. Hist., Ann., vol. 4, 1848, pp. 35–40, pls. 1–2.

Abstract in Neues Jahrbuch, 1839, pp. 248–253.

Refers to localities in the Connecticut valley where fossil fish have been obtained. Mentions previous studies of the fossils in question, and describes and figures *Catopterus gracilis*. Describes, also, another fossil fish, the name of which is not determined. Concludes with brief remarks on the age of the rocks from which the fossil were obtained.

REDFIELD, JOHN H. 1841.

[Zoölogical analogies of *Catopterus gracilis*].

In Final Report Geol. of Massachusetts, by E. Hitchcock. Amherst and Northampton, 1841, 4to, p. 440.

Extract from a letter to E. Hitchcock in which the characteristics of the tail of the fossil fish referred to are briefly discussed.

REDFIELD, JOHN H. 1856.

[Extract from a report to the American Association for the Advancement of Science on the fossil fishes of the United States].

In a paper on the relation of the fossil fishes of the sandstone of Connecticut and other Atlantic states to the Triassic and Jurassic periods, by W. C. Redfield.

In Am. Assoc. Adv. Sci., Proc., vol. 10, pp. 183–185.

Refers to the characteristics of the fishes of the Newark system, and states opinion with respect to geological age.

REDFIELD, J. H. Cited on the age of the Connecticut valley sandstone (J. D. Dana, '56, p. 322. E. Hitchcock, '58, p. 5).

REDFIELD, J. H. Cited on the age of the Newark, as indicated by fossil fishes (W. C. Redfield, '56, pp. 181–187).

Cited on Catopterus from Middletown, Conn. (E. Hitchcock, '41, p. 440).

Cited on *Catopterus gracilis* (C. H. S. Davis, '87, p. 20).

Cited on early discovery of fossil fishes in the Newark system (Newberry, '88, pp. 19–20).

Cited on fossil fishes (E. Hitchcock, '41*b*, p. 244. Newberry, '88. W. C. Redfield, '56*a*, pp. 357–361. H. D. Rogers, '44, p. 251).

Cited on fossil fishes from Connecticut (Anonymous, '38).

Cited on fossil fishes from the Connecticut valley (E. Hitchcock, '41, p. 460. H. D. Rogers, '58, vol. 2, p. 694).

Cited on fossil fishes from the Housatonic valley, Conn. (Redfield, '41, p. 27).

Cited on genus Catopterus (Egerton, '49, pp. 4, 8. W. C. Redfield, '56*a*, p. 361).

Extract from report on fossil fish (W. C. Redfield, '56*a*, pp. 359–361).

REDFIELD, J. H.—Continued.

List of fossil fishes from New Jersey and the Connecticut valley described by (De Kay, '42).

REDFIELD, J. H., and W. C. REDFIELD. 1857.

On the relation of the post-Permean fishes of Connecticut and other Atlantic states to the Triassic and Jurassic periods.

In Edinburg new Philosophical Journal, n. s., vol. 5, pp. 369–370).

An abstract of a paper read by W. C. Redfield at the meeting of the American Association at Albany, N. J. Published in Am. Assoc. Adv. Sci., Proc. [vol. 10], tenth meeting, 1856, pp. 180–188.

REDFIELD, J. H. and W. C. Cited on the age of the Newark (H. D. Rogers, '44, p. 248).

R[EDFIELD, W. C.]. 1838.

Newly discovered ichnolites [at Middletown, Conn.].

In Am. Jour. Sci., vol. 33, pp. 201–202.

Mentions discoveries of fossil footprints in the Connecticut valley, by E. Hitchcock and R. Warner.

REDFIELD, WILLIAM C. 1838a.

Fossil fishes in Virginia.

In Am. Jour. Sci., vol. 34, p. 201.

Brief note referring to a specimen shale with numerous fossil fishes on it, found in the Richmond coal field, Va.

R[EDFIELD, W. C.]. 1839.

[Note on fossil fishes from New Jersey.]

In Am. Jour. Sci., vol. 36, pp. 186–187.

Fossil fishes from Morris county, N. J., are stated to be *Catopterus gracilis* and a species of Palæoniscus, both of which have been found in the sandstone of the Connecticut valley. A previous notice of the fossils mentioned in this article may be found in Am. Jour. Sci., vol. 35, p. 192.

REDFIELD, W. C. 1841.

Short notices of American fossil fishes.

In Am. Jour. Sci., vol. 41, pp. 24–28; abstract in Am. Jour. Sci., vol. 41, pp. 164–165, and also in Am. Assoc. Geol. and Nat., Proc., 1840–1842, pp. 17–18.

Describes several species of Palæoniscus and Catopterus from the Connecticut valley and New Jersey. Remarks on the wide distribution of species in the Newark system.

REDFIELD [W. C.]. 1842.

[Concerning raindrop impressions, footprints, and fossil fishes from the New Red sandstone of New Jersey and the Connecticut valley.]

In Am. Jour. Sci., vol. 43, p. 172; also in Am. Assoc. Geol. and Nat., Proc., 1840–1842, p. 65.

Mentions an observation of fossil raindrop impressions at Newark, N. J.; and also notes the discovery of fossil footprints and fossil fishes in the sandstone of the Connecticut valley.

REDFIELD, W. C. 1842a.

[On some newly discovered ichthyolites in the New Red sandstone of New Jersey.]

REDFIELD, W. C.—Continued.

In London Geol. Soc., Proc., vol. 4, 1845, p. 23.

Mentions newly discovered fossil fish associated with tracks and rain marks.

REDFIELD, W. C. 1843.

Notice of newly discovered fish beds and a fossil footmark in the Red sandstone formation of New Jersey.

In Am. Jour. Sci., vol. 44, pp. 134–136.

Describes the occurrence of fossil fish, a fossil footprint, together with raindrop and hail impressions, and ripple marks produced by waves, at Pompton, N. J.

REDFIELD, W. C. 1843a.

Remarks on some new fishes and other fossil memorials from the New Red sandstone of New Jersey.

In Am. Jour. Sci., vol. 45, pp. 314–315.

Abstract of remarks concerning the age of the Red sandstone of New Jersey as indicated by fossil fish. Mentions also the occurrence of footprints and raindrop impressions.

REDFIELD, WILLIAM C. 1851.

On the post-Permian date of the Red sandstone rocks of New Jersey and the Connecticut valley, as shown by their fossil remains. (Abstract.)

In Am. Assoc. Adv. Sci., Proc., vol. 5, pp. 45–46.

Abstract in Ann. Sci. Discov., 1852, p. 259.

Reference to papers by C. T. Jackson, which assigned the Newark system to the Silurian, and also to the claim of unconformity in the Newark, suggested by D. A. Wells. The conclusion reached is that the Newark presents an unbroken series, and is characterized by a fauna and flora as recent as the Trias.

REDFIELD, W. C. 1851a.

On the fossil rain marks found in the Red sandstone rocks of New Jersey and the Connecticut valley, and their authentic character.

In Am. Assoc. Adv. Sci., Proc., vol. 5, pp. 72–75.

Describes fossil raindrop impressions found at Pompton, N. J., and discusses the nature of their origin.

REDFIELD, W. C. 1856.

On the relations of the fossil fishes of the sandstones of Connecticut and other Atlantic states to the Liassic and Jurassic periods.

In Am. Assoc. Adv. Sci., Proc., vol. 10, 1857, pt. 2, pp. 180–188.

Abstract in Edinburg New Philosophical Journal, n. s, vol. 5, 1857, pp. 369–370; also in Am. Sci. Discov., 1857, p. 338.

Reviews the evidence furnished by the fossil fishes of the Connecticut valley, New Jersey, etc., in reference to the age of the deposits containing them. Proposes the name Newark group.

REDFIELD, W. C. 1856a.

On the relations of the fossil fishes of the sandstones of Connecticut and other Atlantic states to the Liassic and Oölitic periods.

REDFIELD, W. C.—Continued.

In Am. Jour. Sci., 2d ser., vol. 22, pp. 357–363.

Abstract in Neues Jahrbuch, 1857, pp. 87–88.

Reviews the progress that has been made in the study of the fossil fishes of the Newark system, and discusses the question of the age of the system, as indicated by the fossils referred to above.

REDFIELD, W. C. 1857.

On the relation of the post-Permian fishes of Connecticut and other Atlantic states to the Triassic and Jurassic periods.

See Redfield and Redfield, 1857.

REDFIELD, W. C. Adoption of the name, "Newark system," proposed by (Russell, '89*a*).

Cited on age of the Connecticut valley sandstone (E. Hitchcock, '58, p. 5).

Newark system (Lea, '53, p. 193. Lea, '58. Taylor, '48, p. 46).

Red sandstone of New Jersey, Virginia, etc. (J. D. Dana, '56, p. 322).

Cited on Catopteris from the Richmond coal field, Va. (H. D. Rogers, '44, p. 251).

Cited on fossil fishes (C. H. Hitchcock, '71, p. 21. E. Hitchcock, '41*b*, p. 244. Newberry, '88, in many places).

Cited on fossil fishes from Boonton and Pompton, N. J. (Lea, '53, p. 193).

Connecticut valley (Lyell, '66, p. 456).

Richmond coal field, Va. (Lyell, '47, p. 276, pls. 8, 9. W. B. Rogers, '43, pp. 301, 315).

Cited on fossil footprints in New Jersey (E. Hitchcock, '43*a*, pp. 255, 303. Lea, '53, p. 185).

Cited on fossil plants at Little Falls, N. J. (Lea, '53, p. 193).

Cited on genus Catopterus (Egerton, '49, p. 8).

Cited on name "Newark" (C. H. Hitchcock, '71, p. 21).

Cited on Newark system in New York (De Kay, '42, p. 385).

Cited on raindrop impressions from New Jersey (Lyell, '51, pp. 238, 242–244).

List of fossil fishes from New Jersey and the Connecticut valley described by (De Kay, '42).

Notice of the study of fossil fishes by (Miller, '79–'81, vol. 2, p. 147).

Red head, N. B. Beach of magnetic sand near (Bailey, '72, p. 221).

Contact of trap with older sediments (Bailey, '72, p. 220).

Position of (Bailey, Mathews, and Ells, '80, map No. 1 S. E. accompanying).

Rocks of (Bailey, '72, p. 217. Bailey, Mathews, and Ells, '80, p. 21D. Gesner, '39, p. 51).

See also Gardners creek.

Red Hill, Pa. Conglomerate near (H. D. Rogers, '58, vol. 2, p. 680).

Red sandstone hill, Conn. Rock of (Percival, '42, p. 440).

Reids bridge, Va. Boundary of Newark near (Heinrich, '78, p. 237. W. B. Rogers, '39, p. 75).

Reids bridge and Charlotte, Va. Section between (W. B. Rogers, '39, pp. 79-80).

Reid's coal mine, Va. Depth of (Taylor, '48, p. 48).

RENWICK, EDWARD. Cited on fossil fish from New Jersey (W. C. Redfield, '39).

Reptiles, fossil. Distribution of, in time (Emmons, '57, pp. 56-57).

From Connecticut valley (Deane, '45*a*. H. D. Rogers, '58, vol. 2, p. 694. Wyman, '55).

From Newark system (H. D. Rogers, '58, vol. 2, p. 695).

From New Jersey (Cope, '68, p. 733).

From North Carolina (Cope, '75. Emmons, '52, pp. 141-142. Emmons, '56, pp. 293-320, 335-337, 347, pl. 5. Emmons, '57, pp. 54-93, 145-147, pl. 8. Emmons, '57*b*, pp. 77-78).

From Pennsylvania (Lea, '51, pp. 171-172. Cope, '85. H. D. Rogers, '58, vol. 2, pp. 692-693. Wheatley, '61, pp. 44-46. Wheatley, '61*a*).

From Prince Edward Island (Dawson, '78, p. 118. Dawson and Harrington, '71, p. 46).

Found at New London (Dawson, '53).

From Richmond coal field, Va. (W. B. Rogers, '43, p. 300).

Summary concerning (O. C. Marsh, '77. Miller, '79-'81, vol. 2, pp. 243-244).

Rhoad's mill, Pa. Boundary of the Newark near (H. D. Rogers, '41, pp. 16, 39).

Dip of conglomerate at (H. D. Rogers, '41, p. 39).

RICE, WILLIAM NORTH. 1886.

On the trap and sandstone in the gorge of the Farmington river at Tariffville, Conn.

In Am. Jour. Sci., 3d. ser., vol. 32, pp. 430-433.

Describes the outcrop of an overflowed trap sheet with a trap conglomerate resting upon it; and also of the occurrence of a breccia of trap and sandstone. The facts reported in this paper support the conclusion that some of the trap sheets of the Newark were overflows. See Davis, '83.

RICE, WILLIAM NORTH. Cited on origin of the trap hills of Connecticut (Chapin, '87, p. 26).

Cited on overflow trap sheets in Connecticut (W. M. Davis, '88, p. 465).

Rice coal mine, Va. Notes on (Taylor, '35, p. 284, 285).

Rice point, P. E. I. Fossil plants from (Bain and Dawson, '85, pp. 156-158).

Riceville, Va. Boundary of the Newark near (W. B. Rogers, '39, pp. 74-75, 76).

Riceville and Chalk Level, Va. Section between (W. B. Rogers, '39, p. 79).

RICHARDSON, JAMES. 1881.

Report of a geological exploration of the Magdalen islands, 1880-1881.

In Geological Survey of Canada. Report of progress for 1879-'80. Montreal. Pp. 1-11G.

States that there are some reasons for supposing that certain Red sandstones above the Carboniferous of the Magdalen islands may be of Permian or Triassic age, p. 8G.

Richmond, Va. Brief description of coal mines near (Lyell, '54, p. 12).

Richmond bay, P. E. I. Discovery of fossil reptile near (Ells, '84, p. 19E, note 2, on atlas sheet No. 5 S. W.).

Limestone near (Dawson and Harrington, '71, p. 34).

Trap at (Dawson, '78, p. 123. Dawson, '78*a*, pp. 29, 31).

Richmond coal field, Va. Additional notes on (Clifford, '88).

Age of, as indicated by fossil plants (Bunbury, '47, p. 287. Fontaine, '79, pp. 37-39. Foster, '51. E. Hitchcock, '56, p. 99. Lesquereux, '76, p. 283. Lyell, '47, p. 274-280. Lyell, '57. Marcou, '49. Marcou '88, p. 30. W. B. Rogers, '42*c*. W. B. Rogers, '55*a*. Shaler, '71, pp. 114, 115, 117. Zeiller, '88).

Analyses of coal from (Clemson, '35. W. R. Johnson, '50, pp. 175-176. W. R. Johnson, '51, p. 12. Silliman and Hubbard, '42, Williams, '83, p. 82).

Area of (Heinrich, '78, p. 232).

Boundaries of (Heinrich, '78, pp. 230-232).

Brief account of (Ashburner, '87, pp. 352-353. Clifford, '87. Coryell, '75. Daddow and Bannan, '66, pp. 395-403. Emmons, '57, pp. 3, 33, 34. C. H. Hitchcock, '74. Hotchkiss, '73. Hotchkiss, '81, p. 120. Hotchkiss, '83. Hull, '81, p. 460. Le Conte, '82, pp. 457-459. Lyell, '49, pp. 279-288. Lyell, '71, pp. 362-363. Macfarlane, '77, p. 507. Maclure, '09. Mitchell, '42, p. 59-60. Nuttall, '21, pp. 35-37. Patton, '88, pp. 22-23. Pierce, '28, pp. 57-58. W. B. Rogers, '37, pp. 5-6. W. B. Rogers, '40, pp. 71-72. W. B. Rogers, '43*b*, pp. 532-533. Silliman, '42. R. C. Taylor, '34. Williams, '85, pp. 97-98).

Coal from, examination of (W. R. Johnson, '44, pp. 308-451).

For the New Orleans exposition (Hotchkiss, '84).

General character and efficiency of (W. R. Johnson, '50, pp. 133-134, and table op. p. 134).

Organic structure of (Lyell, '47, pp. 268-269).

Coal, production of, in 1885 (Ashburner, '86, p. 69).

In 1887 (Ashburner, '88, p. 361).

In 1883-'84 (Williams, '85, pp. 97-98).

Coal in, brief review of (Chance, '85, pp. 18-19).

Coal mines in, account of (Grammar, '18).

Coal, thickness of (W. B. Rogers, '43).

Coke, natural, and trap dikes in (Heinrich, '75).

Coke, natural, from (W. R. Johnson, '42. Lyell, '47, pp. 270-274. Raymond, '83. W. B. Rogers, '42*b*. W. B. Rogers, '54*a*.

Origin of (Hotchkiss, '83. Stevens, '73).

Remarks on (Coryell, '75. T. S. Hunt, '75, Wurtz, '75).

Depth of shafts in (W. B. Rogers, '43*b*).

Richmond coal field, Va.—Continued.
- Description of (Fontaine, '79, pp. 34–39. W. C. Johnson, '39, p. 41. Lyell, '47. Lyell, '66, pp. 451–452. W. B. Rogers, '36, pp. 52–61. Taylor, '35).
- Description of the mines in (Wooldridge, '42).
- Dip of rocks in (Fontaine, '79, pp. 35, 36).
- Dips in (W. B. Rogers, '43b. p. 533).
- Economic value of (Hotchkiss, '80, pp. 91–92).
- Explosion in Midlothian colliery (Heinrich, '76).
- Extent and boundaries of (Fontaine, '83, pp. 2–4).
- Extract from Lyell's account of (Greer, '71).
- Fire in (Macfarlane, '77, p. 507).
- Fire in the mines of (Taylor, '48, pp. 48–49).
- Fossil fishes of (Lyell, '47, pp. 275–280, pl. 8–9. W. C. Redfield, '38a).
- Fossil plants from (Emmons, '56, pp. 328–329. Emmons, '57, p. 101. Fontaine, '83. Newberry, '76b, p. 148).
  - Description of (Brongniart, '28, vol. 1, pp. 124–126, 391, pls. 14–16, 137. Bunbury, '47. W. B. Rogers, '43. Heer, '57).
- Geology and economic importance of (Taylor, '48).
- Historic and economical account of (Macfarlane, '77, pp. 105–115).
- History of commercial development of (Chance, '85, pp. 22–23).
- Iron ores, brief account of (W. B. Rogers, '80, p. 152).
- Lignite from (W. B. Rogers, '55).
- Midlothian colliery (Heinrich, '73).
  - Condition of in 1876 (Heinrich, '76a).
- Observations of Lyell and Bunbury in (De La Beche, '48).
- Observations of C. Lyell, cited (De La Beche, '48).
- Observations on the structure of (Newell, '89).
- Partial list of fossils from (J. Hall, '52, p. 66).
- Remarks on absence of reptilian remains in (Lyell, '51a).
- Remarks on methods of mining (Coryell, '75).
- Section across (Taylor, '48, p. 47).
  - After Daddow (Le Conte, '84, p. 328).
- Section in (Emmons, '56, p. 339. Emmons, '57, pp. 11–12. Le Conte, '82, p. 457.)
- Section of (W. B. Rogers, '36, pl. —. W. B. Rogers, '39, pl. 2. Rogers, '84, pl. 7–8).
- Sections of dikes in, after C. Lyell (W. M. Davis, '83, p. 281, pl. 9).
- Sections in (Heinrich, '78).
- Structure of (Lyell, '47, pp. 261–268. Shaler, '71, pp. 114, 115, 117).
- Structural features of (Shaler, '77).
- Thickness of rocks in (Fontaine, '79, p. 35).

Richmond county, N. C. Small area of Newark in (Mitchell, '42, p. 130).

Richmond county, N. Y. Account of Red sandstone and conglomerate in (Mather, '43, pp. 285–294).
- Geological map of (Mather, '43, pl. 1).
- Geology of (Mather, '39, pp. 116–117, 122–127).
- Trap rocks of (Mather, '43, pp. 279–282)
- See also Staten Island.

Ridge station, Pa. Boundaries of the Newark in (C. E. Hall, '81, pp. 72–73).

Riegelsville, N. J. Section from, to Trenton, N. J. (Cook, '68, p. 199, and map in portfolio).

Riggs, R. B. Analysis of natural coke from Richmond coal field, by (See Clarke, '87, p. 146).

Righter's quarry at Newark, N. J. Description of (Cook, '81, pp. 48–49).

Ringing rocks, Pa. Trap outcrop near (Cook, '82, p. 63).

Ringoes, N. J. Description of trap, contact metamorphism, etc., near (H. D. Rogers, '40, p. 155).
- Dip in red shale at (Cook, '32, p. 26).
- Dip near (Cook, '68, p. 197).

Riker's hill, N. J. Description of (Cook, '68, pp. 185, 186. Cook, '82, p. 56).
- See also Third Watchung mountain.

Ripple-marks. A peculiar form of, discussed (Shepard, '67).
- In Connecticut valley (E. Hitchcock, '58, pp. 168–169, pls. 43, 50. Warren, '54, p. 46).
  - Conditions of depositions shown by (Lyell, '66, p. 453).
  - Description of (E. Hitchcock, '41, pp. 445–446).
  - Supposed to be tadpole nests (E. Hitchcock, '56, p. 111).
- In New Jersey, localities of (Russell, '78, p. 225).
  - Newark (Lyell, '43, pp. 39–40).
  - Pompton (Cook, '68, p. 201. W. C. Redfield, '43).
  - Weehauken (Gratacap, '86, p. 246).
- In North Carolina (Emmons, '56, pp. 232, 286).
  - Egypt (Emmons, '57, p. 32).
- In Pennsylvania, Coopersburg (H. D. Rogers, '58, vol. 1, p. 101).
  - Phœnixville (Wheatley, '61, p. 45).

River coal mine, Va. Description of (W. B. Rogers, '36, p. 54).
- Notes on (Taylor, '35, p. 284).

Ritzer's mill, Pa. Boundary of the Newark near (Frazer, '80, p. 15).

Roaring brook, Conn. Special account of trap sheets near (Davis and Whittle, '89, pp. 116–118).

Robard's mill, N. C. Boundary of Newark near (Mitchell, '42, p. 130).

Robb, [—]. Cited on age of rocks at cape Tormentin, N. B. (Dawson, '78, p. 124).

Robbins and McGuire. Flagstone quarries of, near Milford, N. J. (Cook, '81, p. 64).

Robinson, J. B. I. Stone quarries of, at Bellville, N. J. (Cook, '89, p. 45).

Robinson and Joyce. Stone quarries of, at Bellville, N. J. (Cook, '81, p. 46).

Rock brook, N. J. Dip along (Cook, '68, p. 197).

Rock church, N. J. Trap rock quarried near (Cook, '81, p. 63).

Rock factory, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 425–426).

Rock falls station, Conn. Description of trap ridges near (Davis and Whittle, '89, p. 114, pl. 3).

Rock ferry, Mass. Dip and strike of rocks at (E. Hitchcock, '41, p. 448).

Rock ferry (South Hadley), Mass. Dip of rocks beneath trap at (E. Hitchcock, '35, p. 223).

Rockingham county, N. C. Account of the geology of (Emmons, '52, pp. 144–153. Mitchell, '42, pp. 133–134).

Rockland county, N. Y. Account of the geology of (Mather, '39, pp. 116–117, 122–127).
Account of the Red sandstone and conglomerate of (Mather, '43, pp. 285–294).
Brief account of the geology of (Emmons, '46, pp. 200–201. Lincklaen, '61).
Character and origin of the Newark conglomerate at (Russell, '78, p. 253).
Description of conglomerate in (Russell, '78. p. 236).
Description of trap ridges in (Darton, '90, pp. 38–39).
Geological map of (Mather, '43, pl. 1).
Section across (Mather, '43, pl. 45).
Table of dips and strikes in (Mather, '43, pp. 616–617).
Trap rocks of (Mather, '43, pp. 278–283).

Rockland lake, N. Y. Brief account of rocks near (Pierce, '20, pp. 186–187).
Dip in sandstone at (Cook, '82, p. 29).
Faults near (Nason, '89, p. 25).
Trap outcrops near (Darton, '90, p. 38. Mather, '43, p. 280).

Rock mill, N. J. Dip near (Cook, '68, p. 197).
Trap outcrop near (Cook, '68, p. 192).

Rock or Sourland mountain, N. J. Described as a trap outcrop (H. D. Rogers, '36, p. 159).

Rocktown, N. J. Boundary of trap near (Cook, '68, p. 192).
Brief reference to trap hills near (H. D. Rogers, 36, p. 159).
Contact phenomena at (Cook, '82, p. 62).
Description of trap, contact metamorphism, etc., near (H. D. Rogers, '40, p. 153).
Dip at (Cook, '68, p. 197).
Dip in indurated shale at (Cook, '82, p. 26).
Trap rock quarries at (Cook, '79, p. 26).

Rocktown, Pa. Contact metamorphism at (H. D. Rogers, '58, vol. 2, p. 687).
Trap dikes at (H. D. Rogers, '58, vol. 2, p. 687).

Rockville, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 56).
Reference to quarries near (C. E. Hall, '81, p. 56).
Unconformity of Newark system with underlying gneiss (H. D. Rogers, '36, pp. 144–145).

Rocky hill, Conn. Contact metamorphism near (E. Hitchcock, '41, p. 657).
Description of (Silliman, '30, pp. 122–131).
Dip of sandstone beneath (Silliman, 30, pp. 122–131).
Fossil fish near (Percival, '42, p. 442).
Fossil footprints near (E. Hitchcock, '41, p. 466. E. Hitchcock, '58, pp. 50 et seq.).
Section of rocks at (Lyell, '42).
Trap ridges near (Percival, '42, pp. 387–388).

Rocky hill, Mass. Description of contact metamorphism at (E. Hitchcock, '35, pp. 422–423).
Locality for fossil footprints (E. Hitchcock, '48, p. 132).

Rocky hill, N. J. Altered shale at (Cook, '68, p. 214).
Analysis of soil from (Cook, '78, pp. 37, 39).
Analysis of trap from (Cook, '68, p. 215).
Bearing of joints at (Cook, '68, p. 201).
Building stone near (Cook, '68, pp. 509–510).
Contact metamorphism at (J. D. Dana, '43, pp. 113–114. H. D. Rogers, '36, pp. 163–164).
Dip in sandstone and shale at (Cook, '82, p. 25).
Dip near (Cook, '68, p. 196).
Dips, diverse, near (Nason, '89, p. 19).
Description of (Cook, '68, pp. 189–190. Cook, '82, pp. 59–60. Darton, '90, pp. 59–61).
Description of trap and associated metamorphosed rock at (H. D. Rogers, pp. 149–152).
Exposure of shale near (Nason, '89, p. 17).
Origin of trap of (Darton, '89, p. 138).
Position of trap near, in the Newark system (Darton, '89, p. 139).
Probable faults near (Nason, '89, p. 26).
Quarries of trap rock at, mention of (G. P. Merrill, '89, p. 436).
Sandstone and trap at (H. D. Rogers, '40, p. 126).
Sandstone quarry at (Cook, '79, p. 24).
Section through (Darton, '90, p. 59).
Trap boundary near (Cook, '68, p. 190).
Trap outcrop near (H. D. Rogers, '36, p. 159).
Trap rock quarries at (Cook, '79, p. 25. Cook, '81, p. 62).

Rocky hill depot, N. J. Trap boundary near (Cook, '68, p. 189).

ROGERS, HENRY D. **1836.**
Report on the geological survey of the state of New Jersey.
Philadelphia, 1836, 2d ed., pp. 1–188, pl. 1.
First ed., Philadelphia, 1836; each edition is paged the same up to p. 174.
Contents relating to the Newark system:

	Page.
Newark system of New Jersey	144–170
General view	144–146
Variegated conglomerate	146–150
Red shale and sandstone	150–159
Trap rocks and contact metamorphism	159–166
Copper ores	166–170

ROGERS, HENRY DARWIN. **1839.**
Third annual report on the geological survey of the state of Pennsylvania.
Harrisburg, Pa., 16mo, pp. 4–119.
Name Middle Secondary strata applied to the Newark, p. 12. Unconformity between the Newark and underlying rocks (other examples are mentioned on p. 21). General dip of the strata; former extension of the Newark beyond its present limits, p. 17. The area occupied by the Newark given by counties, and its northern and southern boundaries described. Occurrence of variegated conglomerate, Red

ROGERS, HENRY DARWIN—Continued.

sandstone, and trap. Localities where variegated conglomerate occurs along the northern border of the area. The hypothesis is here advanced that the sedimentary rocks of the Newark in Pennsylvania, New Jersey, etc., were deposited in their present inclined position by a river rising in Virginia and flowing northward, pp. 18–23.

Trap dikes with accompanying dislocation and metamorphism in the adjacent beds, together with the occurrence of ores of iron and copper along the lines of contact, pp. 18–23.

ROGERS, HENRY D. 1840.

Description of the geology of the state of New Jersey, being a final report.

Philadelphia, pp. 1–301, pl. 1, and map.

Contents relating to the Newark system:

	Page.
Descriptions of the northwest boundary	16, 18
Detailed description	114–171
General description	114–117
The red argillaceous sandstone	117–135
Geological range	117–119
Composition and structure	119–135
Variegated calcareous conglomerate	135–141
Description and geographical range	135–141
The trap rocks and geographical range	141–158
Geographical range	141–143
Composition, structure, and relation to other rocks	143–145
Local features and contact metamorphism	145–158
Somerville trap ridge and Bridgewater copper mine	147–148
New Brunswick	148–149
Rocky hill and its prolongation	149–158
Copper ores	158–165
Economic geology	165–166
Conditions of deposition	166–171

ROGERS, HENRY D. 1841.

Fifth annual report of the geological exploration of the commonwealth of Pennsylvania.

Harrisburg, pp. 1–156, pl. 1.

Describes the Newark rocks bordering the South mountain, Pa., pp. 16–17, 38–39.

ROGERS, HENRY D. 1841a.

[Remarks on the columnar structure of the trap dikes of Pennsylvania and on the magnetic iron ores of New Jersey.]

In Am. Jour. Sci., vol. 41, p. 173; also in Am. Assoc. Geol. and Nat., Proc., 1840–1842, p. 26.

Brief abstract of a remark on a paper by Prof. Mather concerning joints in rocks.

ROGERS, H. D. 1842.

[Remark on the independent origin of the New Red sandstone of the Connecticut valley and of New Jersey and Pennsylvania.]

ROGERS, H. D.—Continued.

In Am. Jour. Sci., vol. 43, pp. 170, 171, 172; also in Am. Assoc. Geol. and Nat., Proc., 1840–1842, pp. 63, 64, 66.

Brief abstract of remarks to the effect that the Newark rocks of the Connecticut valley and of the New Jersey-Pennsylvania area was formed in independent basins.

ROGERS, H. D. 1843.

[Remarks in reference to the age of the Newark system.]

In Philadelphia Acad. Nat. Sci., Proc., vol. 1, p. 250.

States that Posidonomia minuta, from Prince Edward county, Va., indicates that the rocks in which it occurs are the New Red sandstone.

ROGERS, HENRY D. 1843a.

On the physical structure of the Appalachian chain, as exemplifying the laws which have regulated the elevation of great mountain chains generally.

See Rogers, William B. and H. D. Rogers, 1843.

ROGERS, [H. D.] 1843b.

[Remarks on the age of the New Red sandstone of the Connecticut valley and New Jersey.]

In Am. Jour. Sci., vol. 45, p. 315.

Abstract of remarks on a paper by W. C. Redfield.

[ROGERS, H. D.] 1843c.

[On the crescent form of the trappean dikes of the Newark sandstone regions of New Jersey and Connecticut.]

In Am. Jour. Sci., vol. 45, p. 334.

Abstract of remarks on the cause of the topographic form of the trap ridges referred to.

ROGERS, HENRY D. 1844.

Address delivered at the meeting of the Association of American Geologists and Naturalists, held in Washington, May, 1844.

In Am. Jour. Sci., vol. 47, pp. 137–160, 247–278.

Reviews the progress made in the study of the Newark system up to 1844.

ROGERS, H. D. 1848.

[Altered shales and sandstones at New Hope, Pa.]

In Boston Soc. Nat. Hist., Proc., vol. 3, 1848–1851, p. 30.

A brief record of contact metamorphism.

ROGERS, HENRY D. 1853.

[On the thickness of the Connecticut valley sandstone.]

In Boston Soc. Nat. Hist., Proc., vol. 9, 1851–1854, pp. 379–380.

Remarks on a paper by Edward Hitchcock, states that the Newark strata may have been deposited in an inclined position. Refers to instances where the system is not so thick as might be inferred.

ROGERS, H. D. 1853a.

[Remarks on the age of Connecticut sandstone.]

In Am. Acad., Proc., vol. 3, p. 70.

ROGERS, H. D. 1854.

[Remarks on fossil footprints.]

ROGERS, H. D.—Continued.
In Boston Soc. Nat. Hist., Proc., vol. 5, 1854–1855, p. 30.
Brief remarks in discussion of a paper by Bouvé.

ROGERS, H. D. 1855.
[Remarks on footprints and raindrop impressions.]
In Boston Soc. Nat. Hist., Proc., vol. 5, 1854–1856, pp. 182–185.
In describing certain Carboniferous footprints, refers to those of the Newark system, suggests that the so-called raindrop impressions may have been made by spray from breaking waves, p. 185.

ROGERS, HENRY DARWIN. 1856.
Geological map of the United States and British North America.
In The Physical Atlas of Natural Phenomena by Alexander Keith Johnson. New and enlarged ed., pp. 29–32, pl. 8.
Contains a condensed account of the Newark system, including geographical extent, organic remains, and geological age, dip and physical conditions attending its origin, trap rocks, metalliferous veins, coal formation, etc., p. 32.
History of the literature of the Newark system, p. 32.*

ROGERS, HENRY DARWIN. 1858.
The geology of Pennsylvania.
Philadelphia, vol. 1, pp. i–xxvii, 1–586, pl. 36; vol. 2, pp. i–xxiv, 1–1046, pl. 51. Accompanied by an atlas containing a geological map of Pennsylvania in three sheets, a topographical and geological map of the anthracite fields of Pennsylvania in two sheets, and two sheets of sections.
In describing the crystalline and Paleozoic rocks of Pennsylvania, in vol. 1, several references are made to the relation of the Newark system to older formations, and also to its lithological character, strike, dip, trap dikes, ores, etc., pp. 86–87, 88, 89, 90, 92, 101–102, 103, 151, 160, 164, 204, 214.
The following is a table of contents of vol. 2, in as far as it relates to the Newark system:

	Page.
Geographical limits of the sandstone.	667–669
Composition of the Red sandstone...	669–670
On the dip of the strata	670–671
Igneous rocks of the Red sandstone..	671
Detailed description of the members of the Newark system	672–679
Red shale and sandstone	672–675
Boundary of the Red sandstone in Chester county lead mining district	675–677
On the Red shale and sandstone in York and Adams counties	677
Section along the west side of the Susquehanna river	679–680
Lower calcareous conglomerate west of the Susquehanna	679–680
Upper calcareous conglomerate	681–684
Upper calcareous conglomerate southwest of the Susquehanna	682–684
Trap dikes and alterations produced in the strata in contact with them.	684–692
Organic remains and geological age..	692–697
Question of age	693
Red sandstone of the Connecticut valley	694
Organic remains of the main Red sandstone belt of the Atlantic slope ..	695–696
Fossils of Virginia and North Carolina	696–697
Trap dikes of the Wheatley Lode....	702–703
Trap dikes at Elizabeth copper mine, Hopewell furnace, Warwick iron mines, etc.	707
Sketch of the geology of the Older Mesozoic Newark of the United States	759–765
Red sandstone	760–761
Dip of the Red sandstone, and physical conditions attending its origin	761–763
Trap rocks	763
Metalliferous veins	763
Coal deposits	763–764
Fossils	764
Natural coke	764
North Carolina coal field	764
Jura-Trias of the Far West	764–765
Cleavage in Red shale caused by trap dikes	912

ROGERS, H. D. Cited on age of the Connecticut valley sandstone (C. H. Hitchcock, '55, p. 392).
Cited on age of the Newark rocks of Pennsylvania (W. C. Redfield, '56*a*, p. 357).
Newark system (Lea, '53. Lea, '58. Mather, '43, pp. 293–294. Newberry, '88, p. 9. W. C. Redfield, '56, pp. 181).
Richmond coal field, Va. (W. B. Rogers, '43, p. 301).
Cited on conglomerate in New Jersey (Cook, '89, p. 15). York county, Pa. (Frazer, '85, p. 403).
Cited on conglomerate of Virginia (W. B. Rogers, '36, pp. 81–82).
Cited on contact metamorphism in New Jersey (W. M. Davis, '83, p. 301).
New Jersey, at Rocky Hill (J. D. Dana, '43, pp. 113–114).
Cited on curved form of certain trap ridges (W. M. Davis, '83, p. 307. Silliman, '44).
Cited on deposition of the Newark system in inclined strata (W. B. Rogers, '42).
Cited on divisions of the "Middle secondary rocks" of the Atlantic slope (Lea, '53, pp. 191–192).
Cited on extent of Triassic rocks in North America (Archaic, '60, pp. 633–645).
Cited on fossil plants (Marcou, '90. Newberry, '88).
Cited on geological map of the United States (Marcou, '59, pp. 31–35).
Cited on geological position of the Newark system (E. Hitchcock, '41, p. 438).
Cited on intrusive trap sheets in Pennsylvania (W. M. Davis, '83, p. 294).

ROGERS, H. D.—Continued.

Cited on iron ores in Pennsylvania (Frazer, '77, p. 317).

Cited on mode of deposition of the Newark rocks of Pennsylvania (Frazer, '77c, p. 653. Lea, '53, pp. 191–192. E. Hitchcock, '41, pp. 527–529. Mather, '43, pp. 288–292. Mitchell, '42, p. 133).

Cited on monoclinal structure of the Newark (W. M. Davis, '83, p. 302. W. M. Davis, '86, pp. 342–343).

Cited on native silver in New Jersey (Darton, '85).

Cited on Newark system in New Jersey and Pennsylvania (Jones, '62, pp. 88–92).

Pennsylvania (Frazer, '77a, p. 995).

Cited on origin and deposition of Newark strata (W. M. Davis, '83, p. 287).

Cited on origin of the dip in the Newark rocks of Pennsylvania (Macfarlane, '79, p. 41).

Cited on origin of the trap rock of New Jersey (Hovey, '89, p. 376).

Cited on overflow trap sheets in Pennsylvania (W. M. Davis, '83, p. 298).

Cited on prevailing dip of the Newark (W. M. Davis, '83, pp. 305, 306).

Cited as prevailing dip of the Newark in New Jersey and Pennsylvania (W. B. Rogers, '39, p. 72).

Cited on relation of trap and sandstone in New Jersey (W. M. Davis, '83, p. 287).

Pennsylvania (W. M. Davis, '83, p. 287).

Cited on reptilian remains in Newark rocks at Phœnixville, Pa. (Wheatley, '61 p. 42).

Cited on structure of the Newark system (Cook, '87).

Cited on thickness of the Newark in Pennsylvania (Frazer, '77a, pp. 496, 498–499).

Cited on trap at Feltville, N. J. (Darton, '90, p. 26).

Cited on trap dikes in New Jersey (H. D. Rogers, '58, vol. 2, p. 685).

Pennsylvania (W. M. Davis, '83, p. 292. Lewis, '85, pp. 438–439, 441, 443).

Cited on "variegated calcareous conglomerate" of New Jersey (Lea, '53, p. 196. Russell, '78, p. 231–232).

Description of fossil Estheriæ, collected by (Jones, '62, pp. 123–126).

Discussion of hypotheses by, explaining the uniform dip (W. M. Davis, '82a, p. 118).

Hypothesis proposed by, to account for the general inclination of the Newark rocks of New Jersey (Russell, '78, p. 228).

Notice of work by (Miller, '79–'81, vol. 2, p. 147).

Reference to explanation of the structure of the Newark system, by (See Cook, '89a, p. 170).

ROGERS, HENRY D., LARDNER VANUXEM, RICHARD C. TAYLOR, EBENEZER EMMONS, and T. A. CONRAD. **1841.**

Report on the ornithichnites or footmarks of extinct birds in the New Red sandstone of Massachusetts and Connecticut, observed and described by Prof. Hitchcock, of Amherst.

ROGERS, HENRY D., LARDNER VANUXEM, RICHARD C. TAYLOR, EBENEZER EMMONS, and T. A. CONRAD—Continued.

In Am. Jour. Sci., vol. 41, pp. 165–168; also in Am. Assoc. Geol. and Nat., Proc., 1840–1842, pp. 18–21, and in final report on the geology of Massachusetts, by E. Hitchcock, Amherst and Northampton, 1841, 4to; vol. 1, pp. 2a–3a.

Abstract in Neues Jahrbuch, 1841, pp. 739–740.

Report of a committee appointed from the members of the Association of American Geologists and Naturalists, and relates especially to the evidence of the animal origin of the footprints found in the sandstone of the Connecticut valley. The conclusion announced by Hitchcock as to the ornithic character of many of the footprints is sustained.

ROGERS, WILLIAM B. **1836.**

Report of the geological reconnoissance of the state of Virginia.

Philadelphia. Pp. 1–143, pl. 1.

Reprinted in a reprint of annual reports and other papers on the geology of the Virginias, by the late William Barton Rogers. New York, 1884, pp. 21–122, pl. 1.

Contains a detailed account of the Richmond coal field, pp. 52–61, and a brief notice of the presence of sandstone suitable for building purposes in Orange, Nelson, and Amherst counties.

ROGERS, WILLIAM B. **1837.**

Report on the progress of the geological survey of the state of Virginia for the year 1836.

[Richmond.] 4to, pp. 1–14.

Reprinted in a reprint of annual reports and other papers on the geology of the Virginias, by the late William Barton Rogers. New York, 1880, pp. 123–145.

Contains a brief account of the Richmond coal field, and also of the Newark area in northern Virginia, pp. 5–6, 7.

ROGERS, WILLIAM B. **1839.**

Report of the progress of the geological survey of the state of Virginia for the year 1839.

Richmond, 1840. Pp. 1–161, pls. 1–2.

Reprinted in a reprint of annual reports and other papers on the geology of the Virginias, by the late William Barton Rogers. New York, 1889, pp. 285–410, pl. op. p. 276, and pl. 1.

Contains a description of the Newark areas in Pittsylvania, Campbell, Appomattox, Prince Edward, Halifax, Buckingham, and Cumberland counties, Va. The contents are as follows:

	Page.
General features of the formation	69–74
Boundaries of the formation	74–77
In Pittsylvania, Halifax, and Campbell counties	74–76
In Prince Edward, Cumberland, and Buckingham counties	76–77
Character and contents of the formation	77–81

ROGERS, WILLIAM B.—Continued.

Igneous rocks, and associated metamorphism 81-83

ROGERS, WILLIAM B. **1840.**

Report of the progress of the geological survey of the state of Virginia for the year 1840.

Richmond, 1841. Pp. 1-132.

Reprinted in a reprint of annual reports and other papers on the geology of the Virginias, by the late William Barton Rogers. New York, 1884, pp. 411-435.

Contains a description of the boundaries and principal characteristics of the Newark areas in northern Virginia, included in Orange, Culpeper, Prince William, Fauquier, Fairfax, and Loudoun counties, pp. 59-69; and also a description of the boundary of the northern part of the Richmond area, pp. 71-72. On p. 124 a short notice of the occurrence of coke in the Richmond coal field is given.

ROGERS, W. B. **1842.**

[On the prevailing dip in the various areas of New Red sandstone of the Atlantic slope.]

In Am. Jour. Sci., vol. 43, p. 171; also in Am. Assoc. Geol. and Nat., Proc., 1840-1842, pp. 64-65.

An abstract of remarks on the prevailing dip of the Newark system, especially in Virginia, and the slight effect of intrusive rocks on the associated sedimentary beds. The hypothesis proposed by H. D. Rogers, in reference to the strata of sandstone and shale composing the system having been deposited in their present inclined position, is sustained.

ROGERS, W. B. **1842a.**

[Observations tending to show that the footprints on the sandstone of the Connecticut valley were made on inclined surfaces.]

In Am. Jour. Sci., vol. 43, p. 173; also in Am. Assoc. Geol. and Nat., Proc., 1840-1842, p. 66.

Calls attention to the appearance in certain footprints of a slight sliding of the foot which made the impression.

ROGERS, WM. B. **1842b.**

On the porous anthracite or natural coke of eastern Virginia.

In Am. Jour. Sci., vol. 43, pp. 175-176; also in Am. Assoc. Geol. and Nat., Proc., 1840-1842, p. 68.

Brief abstract of a paper describing the structure and mode of formation of the natural coke of Virginia.

ROGERS, W. B. **1842c.**

[On the geological age of the Richmond coal field, Va.]

In Philadelphia Acad. Nat. Sci., Proc., vol. 1, p. 142.

A brief announcement that the rocks of the Richmond coal field are equivalent in time to the Lias of Europe.

ROGERS, WILLIAM BARTON. **1843.**

On the age of the coal rocks of eastern Virginia.

ROGERS, WILLIAM BARTON—Continued.

In Am. Assoc. Geol. and Nat., Trans., 1840-1842, p. 298-316, pls. 13, 14.

Abstract in Am. Jour. Sci., vol. 43, 1842, p. 175; also in Am. Assoc. Geol. and Nat., Proc., 1840-1842, p. 68.

Republished in "A reprint of annual reports and other papers on the geology of the Virginias," by the late William Barton Rogers. New York, 1881, pp. 645-656, and plate.

Describes briefly the rocks of the Richmond coal field, discusses their probable age, and gives descriptions and figures of a number of fossil plants found in them.

ROGERS, W. B. **1843a.**

Observations of subterranean temperatures in the coal mines of eastern Virginia.

In Am. Assoc. Geol. and Nat., Trans., 1840-1842, p. 532-538.

Abstract in Am. Jour. Sci., vol. 43, p. 176; also in Am. Assoc. Geol. and Nat., Proc., 1840-1842, p. 69.

Describes briefly the stratigraphy of the Richmond coal field, thickness of coal, dip of strata, etc., and gives observations of temperature in various mines, the depths of which are stated.

ROGERS, WILLIAM B. **1851.**

[Difficulty of determining the age of the coal beds of North Carolina and Virginia.]

In Am. Assoc. Adv. Sci., Proc., vol. 4, p. 275.

Discussion of a paper by W. R. Johnson.

ROGERS, W. B. **1853.**

[Age of the Deep river coal field, North Carolina.]

In Am. Acad., Proc., vol. 3, 1852-1857, pp. 69, 70.

Abstract of remarks in reference to the similarity of the Newark system in North Carolina, Virginia, and Pennsylvania. Followed by remarks on the age of the same system, by L. Agassiz and T. C. Jackson.

ROGERS, W. B. **1854.**

[Remarks on fossils from the Middle Secondary strata of North Carolina, Virginia, Pennsylvania and Massachusetts.]

In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 14-18; also in Am. Jour. Sci., 2d. ser., vol. 19, 1855, pp. 123-125.

Abstract in Ann. Sci. Discov., 1855, pp. 330-333, and in Am. Jour. Sci., 2d. ser., vol. 19, pp. 123-125.

Describes briefly several of the Newark areas and makes a comparison of their fossils. The conclusion is reached that the fossils indicate a Jurassic age.

ROGERS, WILLIAM B. **1854a.**

[Observations on the occurrence of natural coke in the Richmond coal field, Va.]

In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 53-56.

Reprinted in The Virginias, vol. 4, pp. 158-159.

Abstract in Ann. Sci. Discov., 1855, pp. 320-322.

ROGERS, WILLIAM B.—Continued.

Describes the occurrence of natural coke and its relation to igneous injections. The presence of baked fire clay associated with the coke is also mentioned.

ROGERS, W. B. **1854b.**

[On natural coke in the Richmond coal field, Va.]

In Am. Acad.. Proc., vol. 3, 1852–1857, pp. 106–107.

Describes the natural coke and its relation to a trap sheet. The trap is supposed to have been extruded before the rocks above it were deposited.

ROGERS, W. B. **1855.**

[On lignite from Lancaster county, Pennsylvania, and from the Richmond coal field, Va.]

In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 189–190.

From the similarity of specimens of lignite from the localities mentioned in the title it is concluded that the rocks from which they were obtained are of the same age.

ROGERS, WM. B. **1855a.**

[Remarks on the age of the coal-bearing rocks near Richmond, Va., and of the Newark areas in North Carolina.]

In Boston Soc. Nat. Hist., Proc., vol. 5, p. 186.

The age of the deposits mentioned is considered the same, judging from specimens of lignite from each.

ROGERS, WILLIAM B. **1855b.**

[On a new locality for Posidonomaya in the Mesozoic rocks of Virginia.]

In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 201–202.

From the discovery of specimens of Posidonomaya near the junction of the Bannister and Dan rivers, Virginia, the rocks containing them are correlated with the Mesozoic strata of Prince Edward county and other localities.

ROGERS, WILLIAM B. **1855c.**

[Local metamorphism produced by trap dikes in Prince William county, Virginia.]

In Boston Soc. Nat. Hist., Proc., vol. 5, pp. 202–204.

Describes the character and general strike of the trap dikes of the region mentioned, together with the alteration they have produced on the adjacent shales and sandstones. From the evidences of alteration in sedimentary beds similar to that adjacent to the dikes, over a large area, the hypothesis is suggested that the rocks in question were formerly covered by a trap sheet which has been eroded away.

ROGERS [W. B.]. **1859.**

[Who first discovered the footprints in the Connecticut valley sandstone.]

In Boston Soc. Nat. Hist., Proc., vol. 7, 1859–1861, p. 53.

Relates to the claims of Deane and Hitchcock to priority in the discovery of the footprints in question. Remarks in discussion of a paper by T. T. Bouvé.

ROGERS, W. B. **1860.**

[Remark on the deposition of the inclined strata of the Newark system.]

In Boston Soc. Nat. Hist., Proc., vol. 7, 1859–1861, p. 274.

Refers briefly to the Newark system as an example of the manner in which inclined strata may be deposited.

ROGERS [W. B.]. **1860a.**

[On a block of Red sandstone from Portland, Connecticut, containing impressions of bones, apparently ornithic.]

In Boston Soc. Nat. Hist., Proc., vol. 7, p. 396.

ROGERS [W. B.]. **1860b.**

[On the age of the sandstone on the St. Croix, New Brunswick, and at Perry, Me.]

In Boston Soc. Nat. Hist., Proc., vol. 7, pp. 398–399.

The rocks at the localities mentioned in the title are not admitted to be of Newark age.

In discussion of a paper by C. T. Jackson.

ROGERS, WILLIAM B. **1879.**

List of geological formations found in Virginia and West Virginia.

In American geological railway guide, by James Macfarlane, pp. 179–185.

Describes briefly the Newark (Jurasso-Cretaceous and the Jurasso-Triassic) rocks of Virginia, and indicates their position in the geological column, p. 180.

ROGERS, W. B. **1880.**

The iron ores of Virginia and West Virginia.

In The Virginias, vol. 1, pp. 128–130, 138–140, 152–153, 160–161.

Contains an account of the Mesozoic iron ores of Virginia.

ROGERS, WILLIAM B. **1880a.**

Table of the geological formations found in V[irgini]a and W[est] V[irgini]a.

In The Virginias, vol. 1, pp. 14–15. (Republished in The Virginias, vol. 3, p. 61.)

Indicates the position of the Newark system in the geological column.

ROGERS, WILLIAM BARTON. **1884.**

A reprint of annual reports and other papers on the geology of the Virginias, by the late William Barton Rogers.

New York. Pp. i–xv, 1–832, with 7 plates in volume and 8 plates and 1 geological map in pockets.

Reviewed by J. L. and H. D. Campbell in Am. Jour. Sci., 3d ser. vol. 30. pp. 357–374, vol. 31, pp. 193–202.

The reports and paper in this volume which contain matter relating to the Newark system have been noticed in this index as originally published. The geological map of Virginia, and some of sections on pls. 7–8 were not published originally with the reports.

ROGERS, WILLIAM BARTON. Analysis of coal from the Richmond coal field, Va. Clifford, '87, p. 10).

ROGERS, WILLIAM BARTON—Continued.

Cited on age of the Newark system (Dewey, '57. C. H. Hitchcock, '71, p. 21. E. Hitchcock, '55*a*, p. 407. Hitchcock and Hitchcock, '67, p. 416. Lea, '53, p. 188. Mather, '43, pp. 293–294. Newberry, '88, p. 9. W. C. Redfield, '56, pp. 180–181. Stur, '88, p. 205. Zeiller, '88, p. 698).

Cited on age of the Newark in the Connecticut valley (E. Hitchcock, jr., '55, p. 25).

In New Jersey, Virginia, etc. (J. D. Dana, '56, p. 322).

In North Carolina (Emmons, '56, p. 272. Macfarlane, '77, pp. 517, 528).

In Virginia (Fontaine, '83, pp. 12, 15, 16, 28, 37, 89. E. Hitchcock, '58, p. 6. Horner, '46. Lyell, '47, pp. 261, 279, 280. Lyell, '49, pp. 280–281. Marcou, '49, pp. 273–274. Marcou, '58, pp. 13–15. Macfarlane, '77. W. C. Redfield, '56*a*, p. 357. H. D. Rogers, '58, vol. 2, pp. 693, 696).

Cited on faults in the Richmond coal fields, Va. (W. M. Davis, '83, p. 304).

Cited on footprints from Turners Falls, Mass. (Deane, '56).

Cited on fossils of the Richmond coal field, Va. (Heinrich, '78, p. 264).

Cited on a fossil crustacean from Va. (Jones, '62, pp. 123–126. H. D. Rogers, '43).

Cited on fossil crustaceans (Jones, '62, p. 85).

Cited on fossil plants (Marcou, '90).

Cited on geological position of the Newark system (E. Hitchcock, '41, p. 438).

Cited on intrusive trap sheets in Virginia (W. M. Davis, '83, p. 294).

Cited on mode of formation of the Newark system (E. Hitchcock, '41, pp. 527–529).

Cited on origin of the conglomerate "Potomac marble" on the west border of the Newark of Maryland and Virginia (Lea, '53, p. 189).

Cited on origin of the natural coke of the Richmond coal field, Va. (Hotchkiss, '83. Stevens, '73).

Cited on origin of the Newark system (Cook, '89, p. 13).

Cited on origin of the prevailing dip of the rocks of the Newark system (Newberry, '88, p. 6).

Cited on *Pecopteris whitbyensis* (Emmons, '56, p. 326).

Cited on relation of trap and sandstone in Pennsylvania (W. M. Davis, '83, p. 287).

Cited on Richmond coal field, Va. (Clifford, '87, pp. 4, 25. Taylor, '48, p. 46).

Cited on Tæniopteris from Richmond coal field (Bunbury, '47, p. 281).

Cited on temperatures in coal mines of Richmond coal field, Va. (Taylor, '48, pp. 49–50).

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Roger's point, N. B. Rocks of (Gesner, '41, p. 14).

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RUSSELL, I. C. 1877.

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Indicates briefly the distribution of the various areas of Newark system, pp. 220-222. Describes the Red sandstones and shales, variegated conglomerate, and eruptive rocks of the New Jersey area, pp. 222-246. In treating of this division of the subject numerous details are mentioned, and the conclusion reached that the Newark rocks of New Jersey and of the Connecticut valley were united at the time of their deposition, upheaval and erosion having since separated the two areas.

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In Am. Jour. Sci., 3d ser., vol. 15, pp. 277-280.

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RUSSELL, ISRAEL COOK. 1878b.

On the occurrence of a solid hydrocarbon in the eruptive rocks of New Jersey.

In Am. Jour. Sci., 3d ser., vol. 16, pp. 112-114.

Abstract in Am. Nat., vol. 13, pp. 198-199.

Describes the occurrence of a solid hydrocarbon in the trap of the First Newark mountain, N. J., and refers to previous discoveries of similar substances. See also pp. 130-132 of same volume.

RUSSELL, I. C. 1879.

Footprint in the Mesozoic rocks of New Jersey.

In Am. Jour. Sci., 3d ser., vol. 18, p. 232.

Brief record of the finding of a fossil footprint near Boonton, N. J.

RUSSELL, ISRAEL C. 1880.

On the geology of Hudson county, New Jersey.

In New York Acad. Sci., Ann., vol. 2, 1882, pp. 27-80, pl. 2.

Republished in part in Science (ed. by J. Mitchels), vol. 2, 1881, pp. 63-65.

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In Am. Nat., vol. 14, pp. 703-712.

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RUSSELL, ISRAEL COOK. 1885.

North Carolina coal fields.

In Science, vol. 6, pp. 548-549.

Notice of a report on the coal fields of North Carolina, by H. M. Chance.

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U. S. Geol. Surv., Bull. No. 52, pp. 1-65.

Reviewed by J. D. Dana in Am. Jour. Sci., 3d ser., vol. 39, pp. 317-319.

Discusses the origin of the prevailing red color of the sandstones and shales of the Newark system, pp. 44-55.

RUSSELL, I. C. 1889a.

The Newark system.

In Am. Geol., vol. 3, pp. 178-182.

Reviewed by C. H. Hitchcock in Am. Geol., vol. 5, pp. 200-202.

Gives a list of names and correlations applied to the Red sandstone, shale, etc., which occur in detached area along the Atlantic coast. Suggests that the name, Newark system, proposed by W. C. Redfield, in 1856, be used to designate the system of rocks referred to.

RUSSELL, ISRAEL COOK. 1891.

Has "Newark" priority as a group name.

In Am. Geol., vol. 7, pp. 238-241.

A reply to criticisms by C. H. Hitchcock.

RUSSELL, I. C. Cited on cause of the tilting of the Newark (W. M. Davis, '83, p. 303).

Curved form of certain trap ridges (W. M. Davis, '83, p. 307).

Fossil footprints in New Jersey (C. H. Hitchcock, '88, p. 123).

Former connection of the Newark system in New Jersey and Connecticut valley (Le Conte, '82, pp. 470, 600).

Former extent of the Newark system (Newberry, '88, p. 6).

Geology near Feltville, N. J. (W. M. Davis, '83, p. 275).

Intrusive trap sheets in New Jersey (W. M. Davis, '83, pp. 295, 296. Russell, '78, p. 243).

Newark of New Jersey (Miller, '79-'81, vol. 2, p. 235).

Origin of the red color of Newark sandstones (J. D. Dana, '90, p. 319).

Solid hydrocarbon in the igneous rocks of New Jersey (J. D. Dana, '78).

Structure of the Newark system (Cook, '87).

Trap at Feltville, N. J. (Darton, '90, p. 26).

Trap ridges (Frazer, '82, p. 141).

Discussion of the hypothesis by, explaining opposing dips (W. M. Davis, '82a, p. 119).

Ruth mine, Pa. Detailed account of (d'Invilliers, '83, pp. 350-352).

Rutland, Conn. Description of trap dikes in primary rocks in (Percival, '42, pp. 419–420).

Sable river, P. E. I. Silicified wood at (Dawson and Harrington, '71, p. 16).

Saddle river, N. J. Dip in sandstone at (Cook, '82, p. 24).

Safe Harbor, Pa. Dolerite near (Frazer, '80, pp. 124–125).

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The elementary geology of Tennessee, being also an introduction to geology in general. Designed for the schools of Tennessee.

Nashville, [Tenn.], 12mo., pp. i–vi, 1–255.

Contains a brief general account of the character and distribution of the Jurassic and Triassic systems.

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St. Croix cove, N. S. Description of (Gesner, '36, pp. 190–191. Jackson and Alger, '33, pp. 242–244).

Minerals of (Gesner, '36, p. 190–191. Willimott, '84, p. 25L).

St. George, N. B. Age of rocks at (Bailey, '65, p. 5).

St. Mary's, Pa. Boundary of Newark near (Frazer, '83, p. 234).

Description of iron mine near (H. D. Rogers, '58, vol. 2, p. 708).

Metamorphism, contact near (H. D. Rogers, '58, vol. 2, p. 708).

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Excavation of (Russell, '78, p. 221).

Exposure at (Alger, '27, p. 228).

Rocks near (Gesner, '36, pp. 71–72, 74).

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St. Peter's island, P. E. I. Fossil plants from (Bain and Dawson, '85, pp. 156–158).

Rocks exposed near (Dawson and Harrington, '71, p. 15).

Salmon river, N. S. Description of Newark rocks near (Ells, '85, p. 7E).

Salisbury, N. C. Description of trap dikes near (Tuomey, '44, p. 12).

Salisbury bay, N. B. Position of (Bailey, Matthews and Ells, '80, map No. 1, N.E. accompanying).

Rocks of (Bailey, Matthews, and Ells, '80, p. 21D).

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Extent of Newark rocks at (Dawson, '78, p. 109).

Rocks of (Bailey, '72, pp. 217, 218. Matthew, '65, p. 123).

Salt. Efflorescence of, near Egypt, N. C. (Emmons, '57, p. 96).

Salt in the Deep river coal field, N. C. Mention of an efflorescence of (Jones, '62, p. 90).

Salter's head, N. S. Rocks at (Dawson, '52, p. 399. Dawson, '78, p. 88).

Sandstone at (Dawson, '47, p. 51).

Saltersville, N. J. Building stone near, mention of (Cook, '81, p. 43).

Sandstone quarries at (Cook, '79, p. 21).

Saltonstall mountain, Conn. Description of (Davis and Whittle, '89, pp. 110–111).

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Observations on the origin of (Davis and Whittle, '89, p. 117).

Sandstone on (Davis and Whittle, '89, p. 103).

Small map of north end of (Davis and Whittle, '89, pl. 2).

Small map of posterior ridge of (Davis and Whittle, '89, pl. 3).

Special account of (Davis and Whittle, '89, pp. 122–127).

Saltonstall pond, Conn. Chemical composition of trap rock from near (Hawes, '75).

Overflow trap sheet near (W. M. Davis, '88, p. 464).

Trap ridges near (Percival, '42, p. 323).

Trap rocks near (J. D. Dana, '73, vol. 6, p. 106).

Saltonstall ridge, Conn. Trap of (E. S. Dana, '75).

Salt springs in New Brunswick. Brief notice of (Gesner, '40, p. 43).

Sampson's hill, Va. Isolated coal basin near Heinrich, '78, p. 232).

Samptown, N. J. Dip in shale near (Cook, '79, p. 30. Cook, '82, p. 25).

Dip near (Cook, '68, p. 196).

SANDERS, H. H. 1881.

Geological map of Franklin county, Pennsylvania.

In second geological survey of Pennsylvania, vol. D 5; atlas. No text accompanying.

Sanford, N. C. Analysis of decomposed trap from near. (See, Clarke, '87, p. 138).

Hematite near (Willis, '86, p. 305).

Iron ore near (Kerr, '75, p. 225).

Sand hills, N. J. Trap exposed near (Cook and Smock, '78, p. 233).

Unconformity of Newark and Potomac at (McGee, '88, p. 135).

Sandstone. Albite and orthoclase in (J. D. Dana, '71*b*).

Compiled account of (Cleaveland, '22, p. 759).

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Distribution of, along the Atlantic slope (H. D. Rogers, '58, vol. 2, pp. 759–765).

Sandstone in Connecticut. Brief account of (G. P. Merrill, '89, pp. 446–448, pl. 9).

Containing trap (Hovey, '89, p. 375).

Description of (Percival, '42, pp. 434–436).

Elevation of, in two ranges (Percival, '42, pp. 431–433).

Formed from the débris of primary rocks (Percival, '42, p. 428).

Microscopical characters of (G. P. Merrill, '84, p. 26, pl. 13. G. P. Merrill, '89, p. 304, pl. 2).

Microscopical examination of (Hawes, '78).

Sandstone in the Connecticut valley. Account of (E. Hitchcock, '35, pp. 211–251).

Mode of elevation of (E. Hitchcock, 41, p. 712).

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Theoretical conditions concerning (E. Hitchcock, '35, pp. 243–251).

Sandstone in Maryland. Brief account of (Tyson, '60, appendix pp. 5–6).

Illustration of (Shaler, '84, pl. 45).

Sandstone in Massachusetts. Brief account of (G. P. Merrill, '89, p. 450).

Catalogue of specimens collected in (E. Hitchcock, '41, pp. 804–806).

Description of (E. Hitchcock, '41, pp. 442–443).

Detailed account of (E. Hitchcock, '35, pp. 215–216).

General character of (E. Hitchcock, '35, p. 20).

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Specific gravity of (Walling, '78, pp. 191–192).

Suitable for grindstone (E. Hitchcock, '41, pp. 213–214).

Varieties of (E. Hitchcock, '55, p. 226).

Sandstone in New Jersey. (Cook, '68, pp. 504–512).

Analyses of (Cook, '68, pp. 509, 515–516. Darton, '83. Schweitzer, '70. Schweitzer, '71. Wurtz, '71. Wurtz, '72).

Beneath Palisades (Cook, '81, p. 43. Cook, '82, p. 45. Newberry, '70).

Boundaries of (H. D. Rogers, '40, pp. 117–118).

Brief account of (Nason, '89, pp. 16–17).

Brief general description of (Cozzens, '43, pp. 42–47).

Characters of (Nason, '89, p. 21).

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Lithological description of (Cook, '68, p. 206).

Local details of (Cook, '68, pp. 208–209).

Origin of (Cook, '89, pp. 12–13).

Quarries of (Cook, '81, pp. 42–60. G. P. Merrill, '89, p. 453).

Silica in (Cook, '82, p. 21).

Use of (Shaler, '84, pp. 141–144).

Sandstone in New York. (Mather, '43, p. 287).

Analysis of (Schweitzer, '71).

Brief account of, in Rockland county (Mather, '39, p. 123).

Mode of formation of, discussed (Mather, '43, pp. 289–293).

Quarries of (Mather, '39, pp. 125–126).

Sandstone in North Carolina. (Emmons, '52, pp. 122, 135–136, 155–156. Emmons, '56, pp. 229, 266–267. Kerr, '75, p. 304. McGehee, '83, p. 82. Olmstead, '24, pp. 13–15. Olmstead, '27. Wilkes, '58, pp. 7–8).

Sandstone in Pennsylvania. Brief account of (Frazer, '80, pp. 2–4. d'Invilliers, '83, p. 199).

Description of (H. D. Rogers, '58, vol. 2, pp. 672–679).

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Sandstone in Virginia. Description of (Heinrich, '78, pp. 240–242. W. B. Rogers, '36, p. 56).

Origin of the red color of (Russell, '89, pp. 44–55).

Rapid accumulation of (J. Hall, '55–'59, p. 79).

Relations of, to associated trap rocks (W. M. Davis, '83).

Use of, by engineers (Mahan, '71, pp. 4–5).

Sandy cove, N. S. Description of (Dawson, '78. p. 96. Gesner, '36, pp. 176–184. Jackson and Alger, '33, pp. 226–229).

Minerals of (Gesner, '36, pp. 177–184).

Sandy ford bridge, Va. Boundaries of the Newark near (W. B. Rogers, '39, p. 76).

Sandy Hill, Pa. Boundary of the Newark near (C. E. Hall, '81, p. 72–73).

Sandy hook, N. J. Section from, to near Newburg, N. Y. (Akerly, '20).

Sandy Run, Pa. Boundary of Newark area near (C. E. Hall, '81, p. 20).

Savage's quarry, near Trenton, N. J. Fossil crustaceans found in (Nason, '89, pp. 29, 30).

Sawmill hollow, Conn. Reference to a locality for fossil fish (J. H. Redfield, '36).

Sawratown, Va. Boundary of the Newark near (W. B. Rogers, '39, p. 75).

Schaeffer, (—). Analysis of coal by (Kerr, '75, pp. 293–294).

SCHIMPER, W. PH. **1874.**

Traité de Paléontologie végétale [etc.].

Paris, vol. 1, 1869, pp. i–iv, 1–738, vol. 2, 1870–1872, pp. 1–968, vol. 3, 1874, pp. i–iv, 1–896 and a folio atlas of 110 plates, 1874.

Contains descriptions of a few fossil plants from the Richmond coal field, Va., vol. 1, pp. 276, 610.

SCHIMPER, W. P. Cited on the age of the Newark system (Stur, '88, pp. 205–206).

Schliden's mill, N. J. Trap boundary at (Cook, '68, p. 189).

Schoeneck, Pa. Dip of sandstone at (Frazer, '80, p. 43).

Schomp's mill, N. J. Dip near (Cook, '68, p. 198).

Schuyler's basin, N. J. Sandstone quarry at (Cook, '79, p. 22).

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Description of (Cook, '68, p. 676. H. D. Rogers, '36, pp. 167–168. H. D. Rogers, '40, p. 160. Russell, '80, pp. 33–34, 35).

Schuylkill, Pa. Newark rocks of (Frazer, '83, pp. 224–225).

SCHWEITZER, P. **1870.**

Analysis of Newark sandstone.

In New York Lyc. Nat. Hist., Proc., vol. 1, 1870–'71, p. 136).

Presents an analysis of sandstones from the quarries at Newark, N. J.

SCHWEITZER, P. **1871.**

Notes on the felsites of the Palisade range.

New York Lyc. Nat. Hist., Proc., vol. 1, 1870–'71, pp. 244–252.

Published also in Am. Chem., vol. 2, pp. 23–25.

Gives analysis of five samples of sandstones and shales from the Newark system in New Jersey.

SCHWEITZER, [P.]. Cited as to the composition of trap rocks (W. M. Davis, '83, p. 284).

Cited on analyses of sandstone from New Jersey (Darton, '83. G. P. Merrill, '84, p. 26. Wurtz, '71).

Cited on character of the trap of Bergen hill, N. J. (Newberry, '83).

Scotch Plains, N. J. Boundary of First mountain trap near (Cook, '68, pp. 180, 181, 182).

Columnar trap at (Cook, '68, p. 203).

Description of trap rock near (H. D. Rogers, '40, p. 146).

Dip of strata near (H. D. Rogers, '40, pp. 129, 134).

Gap in First mountain near (Cook, '82, p. 50).

Shale and limestone exposed near (H. D. Rogers, '40, p. 134).

Thickness of Watchung trap sheet at (Darton, '90, p. 22).

"Toadstone," or amygdaloid trap near (H. D. Rogers, '40, p. 144).

SCOTT, F. T., and SONS. Discovery of fossils in quarry of (Wanner, '89, p. 21).

Scotts bay, N. S. Minerals of (Willimott, '84, p. 27L).

Scott's coal mine, Va. Analysis of coal from Clifford, '87, p. 10. Macfarlane, '77, p. 515. Williams, '83, p. 82).

Scottsville, Va. Brief account of sandstone near (W. B. Rogers, '36, pp. 81–82).

Scrabbletown, N. J. Boundary of trap near (Cook, '68, p. 193).

Dip in shale near (Cook, '82, p. 29).

SCUDDER, S. H. **1867.**

[Remarks on an insect larva, *Mormolucoides articulatus*, from the Newark rocks of Massachusetts.]

In Boston Soc. Nat. Hist., Proc., vol. 11, 1866–1868, p. 140.

States that the fossil mentioned is probably the larvæ of Coleoptera.

SCUDDER, SAMUEL H. **1868.**

The fossil insects of North America.

In Geol. Mag., vol. 5, pp. 172–177, 216–222.

Contains a detailed description of fossil insect larvæ, *Mormolucoides articulatus*, from the Connecticut valley.

SCUDDER, SAMUEL HUBBARD. **1886.**

Systematic review of our present knowledge of fossil insects, including Myriapods and Arachnids.

In U. S. Geol. Surv., Bull. No. 31, pp. 1–128.

Mentions the occurrence of *Mormolucoides articulatus* in the sandstone of the Connecticut valley, p. 56.

SCUDDER, SAMUEL H. **1884.**

The oldest known insect larva, *Mormolucoides articulatus*, from the Connecticut river rocks.

In Boston Soc. Nat. Hist., Mem., vol. 3, 1886, pp. 431–438, pl. 45.

Republished in The Fossil Insects of North America. New York, 1890. 4to, vol. 1, pp. 323–336, pl. 19.

Presents a detailed description of the larva referred to, based on the study of a large number of individuals.

Sea cow head, P. E. I. Rocks exposed at (Dawson and Harrington, '71, p. 16).

Sebring's mills, N. J. Boundary of First mountain trap near (Cook, '68, p. 181).

Dip near (Cook, '68, p. 196).

Secaucus, N. J. Dip in sandstone at (Cook, '82, p. 24).

Second mountain, N. J. Description of (Cook, '68, pp. 179–180, 182–185. Cook, '82, pp. 52–54. H. D. Rogers, '40, p. 147).

Dips in the associated sandstone (Walling, '78, p. 196).

Diverse dips near (Nason, '89, p. 18).

On the overflow origin of (W. M. Davis, '82).

Probable faults near (Nason, '89, p. 26).

See also Watchung mountains.

Second Newark mountain, N. J. Brief description of (Russell, '78, pp. 241–242).

Second Watchung mountain, N. J. Detailed description of (Darton, '90, pp. 19–32).

Lower contacts of trap sheet of (Darton, '90, pp. 31–32).

SELWYN, ALFRED R. C., and G. M. DAWSON. **1884.**

Descriptive sketch of the physical geography and geology of the Dominion of Canada.

Montreal. Pp. 55, accompanied by a geological map of the Dominion of Canada, 1842–1882, in two sheets, scale 45 miles to 1 inch.

The extent of both the sedimentary and volcanic rocks of the Newark system in Nova Scotia are shown. Prince Edwards island is colored as Carboniferous.

Seminary ridge, Pa. Trap rocks near. (See Frazer, '82, p. 143).

Seneca, Md. Brief account of rocks near (Ducatel, '37, pp. 20, 24).

Seneca creek, Md. Sandstone quarries at (Shaler, '84, p. 178, pl. 45.

Seneca quarries, Md. Brief account of (Tyson, '60, appendix, p. 5).

Sergeantsville, N. J. Arenaceous strata near (H. D. Rogers, '40, p. 123).

Description of sandstone outcrops near (H. D. Rogers, '36, p. 153).

Section of faulted beds near (Cook, '89, p. 14).

Sewell's quarry, N. C. Unconformity of the Newark and Taconic near (Emmons, '56, p. 242).

SEYMOUR, E. **1868.**

List of minerals in New Jersey.

In Geology of New Jersey, by George H. Cook, 1868. Appendix D, pp. 743–750.

Contains a list of minerals found in New Jersey, including many from the Newark.

Shabakunk creek, N. J. Boundary of Newark along (Cook, '68, p. 176).

Shady side, N. J. Exposure of shale near (Nason, '89, p. 17).

Faults in trap ridge near (Nason, '89, p. 26).

Fossil Estherias and fish scales found near (Nason, '89, p. 30).

Fossil fishes found near (Nason, '89, p. 29).

Shaefferstown, Pa. Boundary of the Newark near (H. D. Rogers, '58, vol. 2, p. 668).

Shale. In Connecticut, bituminous, with the coal seams (Percival, '42, pp. 228, 442).
Detailed description of (Percival, '42, pp. 441-446).
In Massachusetts, brief account of (E. Hitchcock, '35, pp. 216-218).
Description of (E. Hitchcock, '41, p. 443).
In New Jersey (and sandstones), alternation of (Cook, '82, p. 33).
Analysis of (Cook, '68, pp. 384-385. Darton, '83*a*. Schweitzer, '71).
Brief account of (Nason, '89, pp. 16-17, 21).
Colors of (Cook, '82, p. 20).
Description of (Cook, '82, pp. 18, 19-20).
Description of, in Hudson county (Russell, '80).
Detailed description of (H. D. Rogers, '36, pp. 150-159).
Details of (Cook, '68, pp. 212-214).
Dip of (Cook, '79, pp. 29-30).
General account of (H. D. Rogers, '40, pp. 114-117. Russell, '78, pp. 223-231).
Indurated near trap (Cook, '83, pp. 23-24).
Lithological description of (Cook, '68, pp. 206-207).
In New York, in Rockland county (Mather, '43, p. 288).
In North Carolina, in Dan river coal field (Emmons, '52, pp. 156-158).
Deep river coal field (Emmons, '52, pp. 123, 126-127. Wilkes, '58, pp. 8-9).
In Pennsylvania, detailed description of (H. D. Rogers, '58, vol. 2, pp. 672-679).
In Virginia (and slates), detailed description of (Heinrich, '78, pp. 242-243).
Origin of the red color of (Russell, '89, pp. 44-55).

SHALER, N. S. **1871.**
On the causes which have led to the production of cape Hatteras.
In Boston Soc. Nat. Hist., Proc., vol. 14, pp. 110-121.
Refers to the structure and age of the Richmond coal field, pp. 114-115, 117. Structure of the Connecticut valley area, p. 118.

SHALER, N. S. **1875.**
Notes on the investigations of the Kentucky geological survey during the years 1873, 1874, and 1875.
In Kentucky geological survey, Reports of Progress, 2d ser., vol. 3, 4to, pp. 129-282.
Contains brief references to the structural features associated with the Newark system in Virginia and the Connecticut valley, p. 220.

SHALER, N. S. **1884.**
Description of quarries and quarry regions.
In report on the building stones of the United States and statistics of the quarry industry for 1880, in Tenth Census of the United States, vol, 10, part 2, pp. 107-229, pls. 27-58.
Describes the Newark sandstone quarries of Connecticut, pp. 126-127; New Jersey, pp. 141-144; Pennsylvania, pp. 156-157; Maryland, p. 178; Virginia, p. 179; and North

SHALER, N. S.—Continued.
Carolina, pp. 181-182; the trap rock quarries of Connecticut, p. 177; New Jersey, pp. 145-146, and Virginia, p. 179; and the Triassic limestone quarries of Pennsylvania, p. 156, and Maryland, p. 177.

SHALER, N. S. **1885.**
A first book in geology.
Boston, 12mo, pp. i-xvii, 1-255.
Contains a brief account of the life of the Jurassic and Triassic periods, pp. 217-224).

SHALER, N. S. **1885a.**
[Administrative report of Atlantic coast division of the U. S. Geological Survey.]
In U. S. Geol. Surv., Sixth Ann. Rep. of the, pp. 18-22.
States that the Tertiary strata of Martha's Vineyard are in part composed of Newark débris, p. 21.

SHALER, NATHANIEL SOUTHGATE, and WILLIAM MORRIS DAVIS. **1881.**
Illustrations of the earth's surface. Glaciers.
Boston. Folio, pp. i-vi, 1-198, pls. 1-25.
Suggests that the Newark conglomerate of the Connecticut valley may be of glacial origin, pp. 95-96. Section showing ancient periods of glaciation, p. 102.

Sharp island. Mention of (Marsters, '90).

Shell, fossil. From Mount Tom, Mass. (E. Hitchcock, '58, pp. 6-7, pl. 5).
From near Mount Tom, Mass., description of (E. Hitchcock, jr., '56).
From Richmond coal field (Lyell, '47, pp. 274-275).
From Sunderland, Mass. (E. Hitchcock, '23, vol. 6, p. 79).

SHELLEY, J. Y. Discovery of fossil saurian bones in Upper Milford, Lehigh county, Pa., by (Lea, '53, pp. 188, 195).

Shelley's coal mine, Va. Notes on (Taylor, '35, p. 284).

Shelley's ore bank, Pa. Report on (Frazer, '77, p. 222).

Shirley, (—). Cited on thickness of coal seams at Evans, N. C. (Chance, '85, p. 44).

SHEPARD, C. U. **1832.**
Datholite and iolite in Connecticut.
In Am. Jour. Sci., vol. 22, pp. 389-391.
Describes the occurrence of datholite, etc., in trap at Middlefield and Haddam, Conn., and compares these localities with similar localities in New Jersey.

SHEPARD, CHARLES UPHAM. **1837.**
Report on the geological survey of Connecticut.
New Haven, Pp. 1-188.
Abstract in Am. Jour. Sci., 1st ser., vol. 33, pp. 151-175.
Devoted mainly to mineralogy, but contains a brief discussion in reference to the probability of finding coal in Connecticut, pp. 61-62; also a brief description of the building stones of the Newark area, including trap rocks, pp. 98-100. List of Newark specimens collected to illustrate the geology and mineralogy of the state, pp. 165-169.

SHEPARD, CHARLES UPHAM. 1867.

On the supposed tadpole nests or imprints made by the *Batrachoides nidificans* (Hitchcock), in the red shale of the New Red sandstone of South Hadley, Mass.

In Am. Jour. Sci., 2d ser., vol. 43, pp. 99-104.

Discusses the origin of the markings referred to.

Sheolie, N. S. Relation of trap, conglomerate, and sandstone at (Gesner, '43).

Shooter's island, N. Y. Exposures of Newark sandstone and shale on (Britton, '81, p. 168).

Short Hills, N. J. Record of well bored in (Nason, '89*b*).

Short mountain, Conn. Description of (Percival, '42, p. 375).

Detailed study of the geological structure near (W. M. Davis, '89).

Sketch map of (W. M. Davis, '89, pl. 5).

SHRUMP, F. W. Stone quarry of, near Verona, N. J. (Cook, '81, p. 52).

Shuttle meadow, Conn. Detailed study of cross-section at (W. M. Davis, '89, pp. 64-69).

Shuttle meadow mountain, Conn. Anterior trap ridge of (Davis and Whittle, '89, p. 109).

Shuttle meadow reservoir, Conn. Sketch map of (W. M. Davis, '89, pl. 2).

View of fault gap near (W. M. Davis, '89, pl. 2).

Siccomac, N. J. Boundary of First mountain trap near (Cook, '68, p. 180).

Watchung mountain, end at (Cook, '82, p. 49).

Siddonstown, Pa. Trap dike near (H. D. Rogers, '58, vol. 2, p. 689).

Sidney church, N. J. Conglomerate at (Cook, '82, p. 41).

Deformed strata at (Cook, '83, p. 25).

Dip in conglomerate and shale near (Cook, '82, p. 28).

Faults and folds near (Cook, '79, p. 33).

Faults near (Cook, '82, p. 16).

Folds near (Cook, '82, p. 17).

Limestone at (Cook, '82, pp. 22, 42).

Sidney mills, N. J. Dip in shale near (Cook, '82, p. 28).

Sillery, J. Stone quarry of, near Prallsville, N. J. (Cook, '81, p. 59).

SILLIMAN, BENJAMIN. 1810.

Sketch of the mineralogy of the town of New Haven [etc.].

In Connecticut Acad. Arts and Sci., Mem., vol. 1, pp. 83-96.

Contains a general account of the trap exposures near New Haven, Conn.

SILLIMAN, BENJAMIN. 1814.

Mineralogical and geological observations on New Haven and its vicinity.

In Am. Min. Jour., vol. 1, pp. 139-149).

Abstract in Jour. de phys., de chim. [etc.] Par J. C. Delamétherie, Paris, Tome 75, 1812, pp. 75-79.

Notice in Am. Jour. Sci., vol. 1, 1818, pp. 55-56, and in Elementary treatise on Mineralogy and Geology by Parker Cleaveland, 1822, p. 555.

Describes the geology about New Haven, Conn., especially of east and west rocks. Records the finding of a large mass of native copper on the Hamden hills, Conn.

[SILLIMAN, BENJAMIN.] 1818.

Native copper [found near Wallingford, Conn.].

In Am. Jour. Sci., vol. 1, pp. 55-56.

Describes the finding of a mass of native copper.

[SILLIMAN, BENJAMIN.] 1818a.

New localities of agate, chalcedony, chabazite, stilbite, analcite, titanium, prehnite, etc.

In Am. Jour. Sci., vol. 1, pp. 134-135.

Describes the occurrence of minerals at Deerfield, Mass., and at East Haven and Woodbury, Conn.

SILLIMAN, BENJAMIN. 1820.

[Note on the discovery of fossil bones in sandstone at East Windsor, Conn.]

In Am. Jour. Sci., vol. 2, p. 147.

Gives a brief account of the Newark (called Old Red sandstone) of the Connecticut valley; and remarks on the nature of the animal to which the bones referred to belonged.

[SILLIMAN, BENJAMIN.] 1820a.

Sketch of a tour in the counties of New Haven and Litchfield, in Connecticut, with notices of the geology, mineralogy and scenery, etc.

In Am. Jour. Sci., vol. 2, pp. 201-235.

Describes West rock, Connecticut, pp. 202-203, and also the character of the small Newark basin in Woodbury and Southbury, Conn., pp. 231-233.

[SILLIMAN, BENJAMIN.] 1821.

[Remarks on letters from Alexander Brongniart in reference to fossil fishes and native copper from near Middletown, Conn.]

In Am. Jour. Sci., vol. 3, pp. 221-222.

Refers to the finding of fossil fishes, and to the working of copper ore.

[SILLIMAN, BENJAMIN.] 1821a.

[Note on the finding of fossil fish at Sunderland, Mass.]

In Am. Jour. Sci., vol. 3, pp. 365-366.

States that a large number of fossil fish were obtained by Edward Hitchcock, at Sunderland, Mass.

SILLIMAN, B. 1824.

Remarks made on a short tour between Hartford and Quebec in the autumn of 1819.

New Haven, 2d ed., 12mo., pp. 1-443, and 9 plates.

First edition, New Haven, 1820, 12mo., pp. 1-407, and 9 plates.

Contains a general account of the scenery and geology of the Connecticut valley.

SILLIMAN, BENJAMIN. 1827.

[Note on the presence of bituminous coal in the Connecticut valley.]

In Am. Jour. Sci., vol. 12, p. 76).

States that coal has been found at several places in the Connecticut valley.

[SILLIMAN, BENJAMIN.] **1830.**

Igneous origin of some trap rocks.

In Am. Jour. Sci., vol. 17, pp. 119-132, and plate.

Describes the contact of trap with sandstone beneath, at Rocky Hill near Hartford, Conn. The effect of the heat of the trap on the sandstone is discussed, pp. 122-131, and plate.

[SILLIMAN, BENJAMIN.] **1837.**

Bird tracks at Middletown, Conn., in the New Red sandstone.

In Am. Jour. Sci., vol. 31, p. 165.

Brief abstract from a letter stating that footprints as well as bones and fossil plants have been found at the place named.

[SILLIMAN, BENJAMIN.] **1839.**

Fossil fishes in the sandstone of New Jersey.

In Am. Jour. Sci., vol. 35, p. 192.

Notice of the finding of fossil fishes in Morris county, N. J.

Further information regarding these fossils is given by "R." in Am. Jour. Sci., vol. 36, pp. 186-187.

[SILLIMAN, BENJAMIN.] **1842.**

[Note on the Richmond coal field, Va.]

In Am. Jour. Sci., vol. 43, p. 14.

A brief reference concerning specimens received from the Midlothian coal mine, Virginia, value of the coal of that field, etc.

[SILLIMAN, B.] **1843.**

Ornithichnites of the Connecticut river sandstone and the Dinornis of New Zealand.

In Am. Jour. Sci., vol. 45, pp. 177-188.

Publishes letters from J. Deane, G. A. Mantell, and R. Owen relative to the fossil footprints of the Connecticut valley.

SILLIMAN, BENJAMIN. **1844.**

Dr. Percival, the original observer of the crescent-formed dikes of trap in the New Red sandstone of Connecticut.

In Am. Jour. Sci., vol. 46, pp. 205-206.

Relates to an omission to give credit to Percival in a report of a meeting of the Association of American Geologists and Naturalists, published in the Am. Jour. Sci., vol. 45, p. 334.

SILLIMAN, B. Cited on certain polygonal depressions in sandstone from Connecticut valley (E. Hitchcock, '56, p. 111).

Cited on curved form of certain trap ridges (W. M. Davis, '83, p. 307).

Cited on fossil fish from Connecticut (J. H. Redfield, '36).

Cited on fossil footprints (Deane, '45, p. 159).

Cited on metamorphism contact at Rocky hill, Mass. (E. Hitchcock, '35, pp. 422-423).

Cited on native copper in the Connecticut valley (Hoffmann, '22).

Cited on origin of the sandstones of the Connecticut valley (E. Hitchcock, '35, p. 241).

Cited on relation of trap and sandstone in Connecticut (W. M. Davis, '83, pp. 285-286).

Cited on trap rocks near Hartford, Conn. Davis and Whittle, '89, p. 121).

SILLIMAN, B., B. SILLIMAN, jr., and JAMES D. DANA. **1847.**

[Note on phalangeal impressions in fossil footprints.]

In Am. Jour. Sci., 2d ser., vol. 3, p. 276.

Calls attention to a statement by L. Agassiz in reference to the number of phalanges in the toes of birds, and cites similar observations by E. Hitchcock and J. Deane.

[SILLIMAN, B., and J. D. DANA.] **1847.**

[Note on] ornithichnites.

In Am. Jour. Sci., 2d ser., vol. 3, p. 276.

Notes the observations of Hitchcock, Agassiz, and Deane on the number of joints in the toes of fossil footprints from the Connecticut valley. The names of certain fossil footprints found at Turners Falls, Mass., by James Deane, and described in the Am. Jour. Sci., 2d ser., vol. 3, pp. 74-79, are supplied by Hitchcock.

SILLIMAN [BENJAMIN], and [DOUGLASS] HOUGHTON. **1844.**

On the connection of the metallic copper with the trap of Connecticut and Michigan.

In Am. Jour. Sci., vol. 47, p. 132.

A brief discussion of the origin of native copper, frequently associated with trap.

SILLIMAN, B., and O. P. HUBBARD. **1842.**

Chemical examination of bituminous coal from the pits of the Midlothian coal-mining company, south side of James river, 14 miles from Richmond, Va., Chesterfield county.

In Am. Jour. Sci., vol. 42, pp. 369-374.

Gives in detail the result of an examination of a large sample of coal from the locality named.

SILLIMAN and HUBBARD. Analysis of coal from the Richmond coal field, Va. (Clifford, '87, p. 10).

SILLIMAN [B.], Jr. **1841.**

[Remark on rhombic structure in the sandstone of the Connecticut valley.]

In Am. Jour. Sci., vol. 41, p. 173, also in Am. Assoc. Geol. and Nat., Proc., 1840-1842, p. 26.

Brief abstract of remark on a paper by Prof. Mather, concerning joints in rock.

SILLIMAN, BENJAMIN, Jr. **1842.**

[On the cause of the prevailing dip of the New Red sandstone of the Connecticut valley.]

In Am. Jour. Sci., vol. 43, p. 171; also in Am Assoc. Geol. and Nat., 1840-1842, p. 64.

Refers the prevailing dip of the sandstone of the Connecticut valley to upheaval, connected with outbursts of trap. Brief abstract of remarks on a paper by Edward Hitchcock.

SILLIMAN, BENJAMIN, Jr. **1842a.**

[Trap eruption causing upheaval of adjacent strata.]

In Am. Assoc. Geol. and Nat., Proc., 1840-1842, p. 64.

A brief remark in which the inclination of the sandstones of the Connecticut valley is referred to the eruption of trap.

SILLIMAN, BENJAMIN, Jr. 1844.
Report on the intrusive trap of the New Red sandstone of Connecticut.
In Am. Jour. Sci., vol. 47, pp. 107-108.
Abstract in Neues Jahrbuch, 1845, pp. 728-729.
An abstract of a report to the Association of American Geologists and Naturalists, concerning, 1st, the dip of the Connecticut valley sandstone; 2d, the manner in which the trap rocks were intruded, and 3d, the erosion of the formation. The age of the strata is stated to be the "period of the New Red sandstone."

SILLIMAN, B., Jr. 1847.
On fossil trees found at Bristol, Conn., in the New Red sandstone.
In Am. Jour. Sci., 2d ser., vol. 4, pp. 116-118.
Describes the finding of the trunk mentioned.

SILLIMAN, B., Jr. 1847a.
[Note on phalangeal impressions in fossil footprints.]
See Silliman, Silliman, jr., and Dana, 1847.

SILLIMAN, B., Jr., and J. D. WHITNEY. 1855.
Notice of the geological position and character of the copper mine at Bristol, Conn.
In Am. Jour. Sci., 2d ser., vol. 20, pp. 361-368.
Devoted principally to the economic importance of the mine, but describes also its geological position, section of the ore body, etc.

Silver, native, at the Bridgewater copper mine, N. J. (Darton, '85).

Silver Hill, N. J. Description of (Cook, '68, p. 194. Cook, '82, p. 65).
Dip in shale near (Cook, '82, p. 29).

Simsbury copper mine, Mass. Brief account of (E. Hitchcock, '35, pp. 71, 229).

Simsbury, Conn. Building stones in (Percival, '42, p. 439).
Description of sandstone ridge near (Percival, '42, p. 440).

Sindle's mill, N. J. Basaltic columns near (Cook, '68, p. 203).

Skillman station, N. J. Dip in shale at (Cook, '82, p. 25).

Slate, bituminous, in North Carolina (Emmons, '56, p. 268).
Black, in Dan river coalfield, N. C. (McLenahan, '52, p. 171).
With coal, near Leaksville, Va. (W. B. Rogers, '39, p. 78).

Slate Ridge, Pa. Description of trap dike near (Frazer, '80, p. 31).

Slickensides, at North Belleville, N. J. (Cook, '82, p. 16).

SMITH, ALFRED. 1882.
On the water courses, and the alluvial and rock formations of the Connecticut river valley.
In Am. Jour. Sci., vol. 22, pp. 205-231, and map op. p. 205.
Gives the extent and boundaries of the Newark rocks of the Connecticut valley, with a description of principal trap ridges. Refers briefly to the fossils that have been collected, and presents theoretical discussions as to the mode of formation of the sedimentary beds and the origin of the trap.

SMITH, A. Cited on the character of the rocks at Enfield Falls, Conn. (E. Hitchcock, '41, p. 447).

SMITH, EUGENE A. 1878.
Outline of the geology of Alabama.
In handbook of Alabama [etc.], by Saffold Berney, pp. 129-196.
Refers to igneous rocks which are considered as belonging to the Newark system of dikes, pp. 139, 142.

SMITH, EUGENE A. 1883.
Geological survey of Alabama. Report for the years 1881 and 1882.
Montgomery, Ala. Pp. i-xvi, 1-615, and 8 maps.
States that stratified rocks of the Newark system are not known in Alabama, but that the trap dikes of the metamorphic region are usually referred to that period, p. 556.

SMITH, NATHAN. 1820.
Fossil bones found in Red sandstone.
In Am. Jour. Sci., vol. 2, pp. 146-147.
Records the finding of fossil bones at East Windsor, Conn.

SMITH, O. R. Cited on depth of artesian well at Durham, N. C. (Venable, '87).

SMITH, THOMAS P. 1799.
Account of crystallized basalts found in Pennsylvania.
In Am. Philo. Soc., Trans., vol. 4, 1804, pp. 445-446.
A brief account of having seen basalt (trap) near Elizabethtown and Campbellstown, Pa.

SMITH, T. P. Cited on the presence of Jura-Trias in America (Lea, '53, p. 189).

SMITH, W. Discovery of saurian bones by, at Springfield, Mass. (E. Hitchcock, '58, p. 186).

Smith iron mine, N. C. Brief account of, with sketch (Willis, '86, p. 305).

Smith's Ferry, Mass. Brief account of a visit to (Lyell, '45, vol. 1, p. 252).
Dip of rocks at (Lyell, '42).
Fossil footprints at (E. Hitchcock, '58, pp. 50 et seq.).
Relation of conglomerate, trap, and sandstone at (Lyell, '42, p. 794).
Section of rocks at (Lyell, '42).

Smith's hill, N. J. Described briefly as a trap outcrop (H. D. Rogers, '36, p. 159).
Description of trap and sandstone near (H. D. Rogers, '36, p. 156).
Detailed description of (H. D. Rogers, '40, p. 151).
Quarries of trap rock at, mention of (G. P. Merrill, '89, p. 436. Cook, '79, p. 26. Cook, '81, p. 62).

Smithville, N. J. Description of sandstone outcrops near (H. D. Rogers, '36, p. 153).

SMOCK, JOHN C. 1878.
Geological survey of New Jersey. Report on the clay deposits of Woodbridge, South Amboy, and other places in New Jersey.
See Cook, G. H., and J. C. Smock, 1878.

SMOCK, JOHN C. 1890.
Building stones in New York.
New York State Museum Bull., vol. 2, No. 10, pp. 193–396, and map.
Describes the building stones of the Newark system in New York, pp. 225–226, and the use of building stone from other areas of the same system in New York city, pp. 294–304.

SMOCK, J. C. Cited on sandstone at Princeton, N. J. (Shaler, '84, p. 144).

Smyser's mine, Pa. Report on (Frazer, '77, pp. 217–218).

Snake hill, N. J. Described briefly as a trap outcrop (H. D. Rogers, '36, p. 159).
Description of (Cook, '68, pp. 178–179. Cook, '82, pp. 47–48. Russell, '80, pp. 34, 36).
Detailed description of trap at (Darton, '90, pp. 55–56).
Dip in sandstone at (Cook, '79, p. 30. Cook, '82, p. 24. Russell, '80, p. 34).
Location of (Nason, '89, p. 37).
Origin of (Darton, '89, p. 138).
Sandstone quarries at (Cook, '79, p. 22).
Trap rock quarries at (Cook, '79, p. 25. Cook, '81, p. 62).
Mention of (G. P. Merrill, '89, p. 436).

Sneden's landing, N. Y. Character of trap ridge near (Darton, '90, p. 48).
Dip in sandstone at (Cook, '82, p. 24).
Escarpment of trap at (Cook, '68, p. 177).

Sneedsboro, N. C. Breadth of Newark rocks near (Olmstead, '24, p. 12).

Snydertown, N. J. Boundary of trap near (Cook, '68, p. 192).
Contact phenomena at (Cook, '82, p. 62).
Dip in indurated shale at (Cook, '82, p. 26).
Dip near (Cook, '68, p. 197).

Soils in New Jersey. (Cook, '68, pp. 226–227. Cook, '79, p. 14).
From shale near New Brunswick (Cook, '78, p. 24).
From trap (Cook, '78, pp. 37, 39. Nason, '89, p. 37).
From trap and sandstone (Cook, '82, p. 66).
From trap of Sourland mountain (Cook, '68, p. 192).

Soils in Nova Scotia. (Dawson, '78, p. 112).

SOLOMON, R. G. Record of well bored at Newark, N. J. (Nason, '89*b*).

Somers, Conn. Report of the finding of coal at (E. Hitchcock, '23, vol. 6, p. 63).

Somerville, N. J. Analysis of copper ore from (Bowen).
Artesian wells near (Cook, '85, pp. 113–114).
Bitumen near (Beck, '39).
Contact of trap and sandstone near (Cook, '82, pp. 51–52).
Copper mine near (Cook, '83, p. 164).
Copper mine near, description of the Bridgewater (H. D. Rogers, '36, pp. 168–169).

Somerville, N. J.—Continued.
Copper mines near, description of (H. D. Rogers, '40, p. 162).
Copper ore at (Cook, '71, pp. 55–56).
Copper ore, locality for (H. D. Rogers, '36, p. 166).
Dip in shale and sandstone near (Cook, '82, p. 29).
Dip in shale near (Cook, '79, p. 30).
Dip near (Cook, '68, p. 198).
Occurrence of native silver near (Darton, '85).
Section across Watchung mountains, near (Cook, '83, p. 166 and plate).
Trap outcrops near (Darton, '90, p. 70).

Somerville trap ridge, N. J. Description of (H. D. Rogers, '40, pp. 147–148).

Sorrel horse, Pa. Boundary of the Newark near (Lesley, '85, p. lxxxi).

Souris, P. E. I. Newark rocks exposed near (Dawson and Harrington, '71, p. 15).

Sourland mountains, N. J. Altered shale near (Cook, '68, pp. 212–214. Cook, '83, p. 24).
Course of (Cook, '82, p. 19).
Description of (Cook, '68, pp. 191–192. Cook, '82, pp. 61–62. Darton, '90, pp. 61–65. H. D. Rogers, '40, pp. 152–158).
Dip at (Cook, '68, pp. 191, 197, 198).
Dip in indurated shale at (Cook, '82, p. 26. Cook, '82, p. 29).
Metamorphism (contact) at (Cook, '68, p. 191).
Metamorphism (contact) near (Cook, '87, p. 125).
Origin of trap of (Darton, '89, p. 138).
Position and extent of (Nason, '89, p. 35).
Probable faults near (Nason, '89, p. 25).
Section through (Darton, '90, p. 59).
Trap ridge near (Cook, '82, p. 60).

Sourland mountain trap. Position of, in the Newark series (Darton, '89, p. 139).

Southampton, Mass. Concerning coal at (E. Hitchcock, '35, p. 231).
Conglomerate in (E. Hitchcock, '35, p. 214).
Report of the finding of coal at (E. Hitchcock, '23, vol. 6, p. 63).

Southampton, Pa. Boundary of the Newark in (C. E. Hall, '81, pp. 56–57).

Southampton township, Pa. Report on the geology of (C. E. Hall, '81, pp. 56–57).

South Branch, N. J. Dip at (Cook, '68, p. 197).
Dip in shale near (Cook, '82, p. 28).

South Britain, Conn. Evidence of faults near (W. M. Davis, '88, pp. 469–471).
Ideal sections of trap ridges near (W. M. Davis, '88, p. 471).
Sandstone resting on Primary rocks in (Percival, '42, p. 450).
Sketch map of trap ridges near (W. M. Davis, '88, p. 470).

Southbury, Conn. Age of the Newark system of, as indicated by fossil fishes (W. C. Redfield, '56, pp. 180–181).
Brief account of Newark area in (E. Hitchcock, '35, p. 220).
Brief account of Newark rocks in (E. Hitchcock, '28, pp. 227–228).

Southbury, Conn.—Continued.
  Brief account of trap ridge of the Newark system of (E. Hitchcock, '35, p. 513).
  Description of fossil fishes from (W. C. Redfield, '41, p. 27).
  Description of fossil wood from (E. Hitchcock, '43*b*, pp. 294–295).
  Description of rocks at (E. Hitchcock, '43*b*, p. 294).
  Description of trap ridge in (Percival, '42, pp. 410–412).
  Reference to Newark area in (E. Hitchcock, '41, p. 446).
  Reference to Newark rocks in (Russell, '78, p. 238).
Southbury area, Conn. Brief account of (Whelpley, '45, p. 62).
  Brief description of (J. D. Dana, '75, pp. 404, 405. W. M. Davis, '88, pp. 468–469. Silliman, '20*a*, pp. 231–233).
  Considered a remnant left by erosion (Russell, '78, p. 239).
South Carolina. Account of the geology of (Lieber, '56).
  Brief account of the Newark system in (Henderson, '85, p. 88).
  Brief accounts of trap dikes in (Hammond, '84, pp. 466–497).
  Description of trap dikes of (Tuomey, '44).
  Map of Chesterfield county, in (Lieber, '56, pl. 6).
  Mention of slates and trap rocks of supposed Newark age (Butler, '83).
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  Metamorphism (contact) in (Tuomey, '48, pp. 48, 103–104, 113).
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South Durham, Conn. Trap ridges near (Davis and Whittle, '89, p. 107).
South Durham mountain, Conn. Chemical composition of trap from (Hawes, '75).
South Hadley, Mass. Boring for coal at (E. Hitchcock, '41, p. 525).
  Brecciated trap at contact of trap and sandstone at (E. Hitchcock, '41, p. 658).
  Brief account of sandstone near (E. Hitchcock, '35, pp. 220–221).
  Character of sandstone at (E. Hitchcock, '41, pp. 446–447).
  Coal at, examination for (E. Hitchcock, '35, pp. 53–54).
    Report of the finding of (E. Hitchcock, '23, vol. 6, p. 63).
  Coal found in (E. Hitchcock, '41, pp. 139–140).
  Coal in (E. Hitchcock, '35, p. 231).
  Dip and strike of rocks in (E. Hitchcock, '41, p. 448).
  Dip at (E. Hitchcock, '35, p. 223).
  Discussion of the origin of so-called tadpole nests from (Shepard, '67).

South Hadley, Mass.—Continued.
  Fossil bones at, brief account of (Wells and Bliss, '50).
  Fossil bones from (Wells, '50, p. 340).
  Fossil footprints at (E. Hitchcock, '58, pp. 49, 50, et seq.).
    Discovery of (E. Hitchcock, '58, p. 3).
  Fossil footprints found near (D. Marsh, '48, p. 272).
  Fossil footprints from (Deane, '61).
    Description of (C. H. Hitchcock, '88, p. 125. E. Hitchcock, '36, p. 320–325. E. Hitchcock, '41, pp. 478–501. E. Hitchcock, '47. E. Hitchcock, '48).
    In New York state cabinet (Anonymous, '54).
    Mention of (E. Hitchcock, '55*a*, p. 183).
    Reference to (Macfarlane, '79, p. 63).
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    Localities of (E. Hitchcock, '41, pp. 465, 466. E. Hitchcock, '48, p. 132).
  Fossil footprints in museum at (C. H. Hitchcock, '88, p. 121).
  Fossil plants from (E. Hitchcock, '41, p. 452, pl. 29).
    Reference to (E. Hitchcock, '35, p. 235).
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  Remarks on recent and fossil raindrop impressions observed at (Merrick, '51).
  Trap-tuff or tufaceous conglomerate at (E. Hitchcock, '44*e*, p. 7).
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Southington, Conn. Brief reference to fossil fishes at (E. Hitchcock, '37, p. 267).
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  Trap dikes in (C. E. Hall, '81, p. 20).
Southwick, Conn. Building stone in (Percival, '42, p. 439).
Southwick ponds, Conn. Description of trap ridges near (Percival, '42, p. 408).

Spencer's Island, N. S. Copper at (How, '69, p. 65).
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Section across Connecticut valley at (E. Hitchcock, '58, pl. 2).
Unconformity in the Newark at (Wells, '50, p. 340).

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Starrs point, N. S. Coast section near (Dawson, '47, p. 56).
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Records certain observations which are thought to prove that the natural coke has not been formed by the action of the heat of trap dikes or associated coal seams, as supposed by W. B. Rogers.

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Contact metamorphism near (Gesner, '36, p. 254).

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Exposures of Newark rocks near (Dawson, '47, p. 54).

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Minerals near (Willimott, '84, p. 28L).

Swan creek, N. S.—Continued.

Rock near (Dawson, '78, pp. 102–104).

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Small map of trap ridges near (Davis and Whittle '89, pl. 3).

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TAYLOR, F. W. Analysis of sandstone from Connecticut by (Shaler, '84, p. 127).

TAYLOR, R. C. **1834.**

[Richmond coal basin and its coal trade.]

In Pennsylvania Senate Journal, vol. 2, 1833–'34, p. 567.

Not seen.

TAYLOR, RICHARD C. **1835.**

Memoir of a section passing through the bituminous coal field near Richmond, Va.

In Pennsylvania Geol. Soc., Trans., vol. 1, pp. 275–294, pl. 16–17.

Describes the general character of the Richmond coal field, together with the thickness and quality of the coal as exposed in a number of mines.

TAYLOR, RICHARD C. **1835a.**

Review of geological phenomena, and the deductions derived therefrom, in 250 miles of sections in parts of Virginia and Maryland. Also notice of certain fossil acotyledonous plants in the secondary strata of Fredericksburg.

In Pennsylvania Geol. Soc., Trans., vol. 1, pp. 314–325, pl. 18–19.

Contains a brief mention of Newark sandstone and conglomerate on the Potomac river in Maryland, p. 320.

TAYLOR, RICHARD C. **1841.**

Report on the ornithichnites or footmarks of extinct birds, in the New Red sandstone of Massachusetts and Connecticut, observed by Prof. Hitchcock, of Amherst.

See Rogers, Vanuxem, Taylor, Emmons, and Conrad, 1841.

TAYLOR, RICHARD COWLING. **1848.**

Statistics of coal [etc., etc.],

Philadelphia, pp. i–cxlviii, 1–754, and six maps.

Second edition, Philadelphia, 1855, pp. i–xx, 1–640.

Gives a brief review of previous writings on the Richmond coal field and states the amount of coal produced per year from 1822–1828.

The age and structure of the deposit are also considered.

TAYLOR, R. C. Cited as to age of the coal fields of North Carolina (Emmons, '56, p. 271).

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Section of coal seams at (Chance, '85, p. 40).

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Taylorsville, Va. Description of Newark area near (Heinrich, '78, pp. 229–230).

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Tenafly, N. J. Mention of building stone near (Cook, '81, p. 43).

Ten-mile creek, N. B. Dip near (Gesner, '41, p. 14).

Newark rocks at (Matthew, '65, p. 123).

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Dip in sandstone at (Cook, '82, p. 25).

Sandstone quarry at (Cook, '79, p. 24).

Ten-mile run mountain, N. J. Analysis of soil from (Cook, '78, pp. 37, 39, and map).

Copper ores near (Cook, '68, p. 679).

Description of (Cook, '68, pp. 189–190. Cook, '82, pp. 59–60).

Detailed description of (Darton, '90, pp. 59–61).

Position of trap near, in the Newark system (Darton, '89, p. 139).

Trap rock of (Cook, '82, p. 18).

Terrace hill, Pa. Boundary of the Newark near (Frazer, '80, pp. 15, 48).
Thatcher's, R., quarry, near Klinesville, N. J. Fossil Estherias found in (Nason, '89, p. 30).
Thickness of coal. At Evans, N. C. (Chance, '85, pp. 44, 45).
At Gulf, N. C. (Chance, '85, p. 41).
At Midlothian, Va. (Chance, '85, p. 19).
At Murchison, N. C. (Chance, '85, p. 49).
In Egypt shaft, N. C. (Chance, '85, p. 35).
In Richmond coal field, Va. (Lyell, '66, p. 452. Lyell, '47, pp. 263, 264, 265, 267. Newell, '89).
Near Leaksville, N. C. (Chance, '85, p. 64).
Thickness of coal and of natural coke. In the Richmond coal field, Va. (Coryell, '75).
Thickness of sandstone. Near Leaksville, N. C. (Emmons, '57, p. 22).
Near Madison, N. C. (Emmons, '57, p. 22).
Thickness of the Newark. (Cook, '88. Kerr, '75*a*. Newberry, '88, p. 5).
Brief statement concerning (J. D. Dana, '56, p. 322. H. D. Rogers, '56, p. 32).
Briefly discussed (Kerr, '74).
General observations concerning (J. D. Dana, '75, p. 421).
In Connecticut (J. D. Dana, '73, vol. 5, p. 427).
Indicated by a well at New Haven (J. D. Dana, '83, p. 386).
In Woodbury-Southbury area (W. M. Davis, '88, p. 468).
In the Connecticut valley (J. D. Dana, '71, pp. 46–47. J. D. Dana, '79. W. M. Davis, '88, p. 467. E. Hitchcock, '53. E. Hitchcock, '58, pp. 11–15. Le Conte, '82, p. 453. Newberry, '88, p. 5. H. D. Rogers, '56, p. 32. A. Smith, '32, pp. 219–220).
In Massachusetts (E. Hitchcock, '55, p. 226. E. Hitchcock, '35, pp. 224–228. Emerson, '91).
At Greenfield, Mass. (Emmons, '57, pp. 5, 6–9, 22).
At Mount Tom (E. Hitchcock, jr., '55, p. 23).
In New Brunswick, at Quaco Head (Dawson, '78, p. 108).
In New Jersey (Cook, '68, p. 174. Cook, '79, pp. 30–31. Cook, '82, pp. 12–14. Cook, '89, p. 13).
At Newark and Paterson (Shaler, '84, pp. 142–143).
Discussion of (J. D. Dana, '79).
Estimates of (Cook, '87. Darton, '89, p. 139. Russell, '80*a*).
Near Amsterdam (Cook, '68, p. 175).
Near Sufferns (Cook, '68, 175).
In New York (Darton, '90).
In North Carolina (Emmons, '56, pp. 231-232. Emmons, '57, p. 30. Kerr, '75, p. 145).
Discussion of (Chance, '85, pp. 15–16).
Egypt (Fontaine, '83, p. 100).
Gulf (Emmons, '57, p, 22).
Haywood (Fontaine, '83, p. 100).
In Dan river coal field (Daddow and Bannan, '66, p. 405).
Thickness of the Newark—Continued.
Near Farmersville (W. R. Johnson, '51, p. 8).
Near Farmville (Chance, '85, pp. 28–35).
On Deep river, N. C. (Chance, '85, pp. 20, 21. Daddow and Bannan, '66, p. 405. Emmons, '52, pp. 137-139. Jones, '62, p. 91. Macfarlane, 77, pp. 518–519).
In Nova Scotia, at St. Mary's bay (Jackson and Alger, '33, pp. 234–235).
In Pennsylvania (Frazer, '77*c*, p. 651. Lesley, '83, pp. 189–190. Lesley, '91).
Discussion of (Frazer, '77*a*, pp. 495–497, 498–499).
Estimate of (Lesley, '83, pp. 180–181).
In Adams county, estimate of (Frazer, '77, pp. 270, 303).
In Berks county (d'Invilliers, '83, pp. 200–201).
In Bucks county, estimate of (Lesley, '85, p. xxv).
In Chester county, calculation of (Lesley, '83, p. 180).
In York county (Frazer, '85, pp. 402–403).
In Virginia, Richmond coal field (Clifford, '87, pp. 4, 23–24. Daddow and Bannan, '66, p. 398. Fontaine, '83, pp. 6–7. Frazer, '85, p. 403. Le Conte, '82, p. 457. Lyell, '47, pp. 263, 271, 272. Taylor, '35).
Mention of (Hitchcock and Hitchcock, '67, p. 416).
Remark on (H. D. Rogers, '53).
(So-called) on Prince Edward island (Bain and Dawson, '85, p. 155. Dawson, '72, p. 203. Dawson, '78, pp. 29, 31. Dawson and Harrington, '71, pp. 14, 15).
Thickness of trap in Connecticut, Pond rock (Hovey, '89, pp. 364–365).
Southern (Hovey, '89, p. 378).
In Connecticut valley (Whelpley, '45, p. 63).
In New Jersey (Cook, '82, p. 46. Darton, '90).
Watchung trap sheets (Darton, '89, p. 137. Darton, '90, p. 21).
In Virginia, Richmond coal field (Lyell '47, pp. 271, 272).
Near Carbon hill (Clifford, '87, pp. 11–12).
Third mountain, N. J. Analysis of trap from (Cook, '68, p. 217).
Description of (Cook, '68, p. 185).
Detailed description of (Darton, '90, pp. 32–39).
Dips in the associated sandstone (Walling, '78, p. 196).
See, also, Long Hill.
See, also, Watchung mountains.
Thompson's mills, N. J. Boundary of trap near (Cook, '68, p. 192).
Thoroughfare Gap, Va. Boundary of the Newark near (W. B. Rogers, '40, p. 63).
Three ridges, N. J. Trap outcrops near (Darton, '90, p. 70).
Tine's, E., N. J. Dip near (Cook, '68, p. 197).
Tinicum creek, N. J. Dip in shale at (Cook, '82, p. 27).
Tippecanoe coal mine, Va. Analysis of coal from (Williams, '83, p. 82).

Tippecanoe coal mine, Va.—Continued.

Character and efficiency of coal from (W. R. Johnson, '50, pp. 133–134, and table op. p. 134).

Trial of the coal of, for heating purposes (W. R. Johnson, '44, pp. 405–419, 421).

Titan's piazza, Mass. Brecciated trap at contact of trap and sandstone (E. Hitchcock, '41, p. 658).

Titan's pier, Mass. Account of the trap rock of (E. Hitchcock, '41, pp. 641–643).

Brecciated trap at contact of trap and sandstone (E. Hitchcock, '41, p. 658).

Columnar trap at (E. Hitchcock, '35, pp. 401–402).

Contact metamorphism observed at (E. Hitchcock, '35, p. 424).

Dip and strike of rocks at (E. Hitchcock, '41, p. 448).

Titusville, N. J. Dip near (Cook, '68, p. 197).

Dip of shale at (Cook, '79, p. 29. Cook, '82, p. 26).

Quarries of trap rock at, mention of (G. P. Merrill, '89, p. 436).

Trap rock quarries near (Cook, 79, p. 26).

Trap rock quarried near (Cook, '81, p. 62).

Section through (Darton, '90, p. 61).

TODD, J. Cited on the discovery of a mass of native copper on Hamden hills, Conn. (Silliman, '14, p. 149).

Toket mountain, Conn. Anterior trap ridge of (Davis and Whittle, '89, p. 107).

Description of main ridge of (Davis and Whittle, '89, p. 111).

Description of trap ridges near (Percival, '42, pp. 326–327, 339, 343).

Description of, with discussion of geology (Hovey, '89).

Discussion of the geological structure of (W. M. Davis, '86, p. 346).

Fault near (W. M. Davis, '88, p. 473).

Formed by an overflow trap sheet (W. M. Davis, '88, pp. 464, 467).

Limestone near (Percival, '42, pp. 316, 443).

Sandstone in shale under (Percival, '42, p. 442).

Sketch map of (W. M. Davis, '88, p. 479).

Small map of north end of (Davis and Whittle, '89, pl. 2).

Small map of south end of (Davis and Whittle, '89, pl. 2).

Strike and dip of sandstone near (Hovey, '89, pp. 370–371).

Structure of (W. M. Davis, '88).

Structure of trap rocks of (Percival, '42, p. 313).

Topographic form of (Percival, '42, p. 303).

Trap conglomerate on (Percival, '42, p. 316).

Toket and Pond mountains, Conn. Bird's-eye view of (W. M. Davis, '88, p. 480).

Tompkinsville, Richmond county, N. Y. Brief reference to trap rocks near (Mather, '38).

Joints and veins near (Mather, '43, p. 625).

Tooley's point, N. B. Rocks of (Gesner, '40, p. 19).

TORREY [JOHN]. **1820.**

[Note on Datholite from Paterson, N. J.]

In Am. Jour. Sci., vol. 2, p. 369.

Brief account of chemical tests to show the character of the mineral in question.

TORREY [JOHN]. **1822.**

Summerville copper mine [New Jersey].

In Am. Jour. Sci., vol. 5, p. 401.

Describes the location of the mine and gives a list and description of minerals found there.

TORREY, J. Cited on the trap of the Palisades, N. J. (Pierce, '20, p. 183).

Totowa, N. J. Boundary of Second mountain trap near (Cook, '68, p. 183).

Towakhow mountain, N. J. Analysis of trap from (Cook, '68, p. 217).

Description of (Cook, '68, p. 186. Cook, '82, pp. 54–55).

Origin of (Darton, '89, p. 173).

See Third Watchung mountain.

Toughkenamon, Pa. Mention of a trap dike near (Frazer, '84, p. 693).

Trap. Amount of iron in (Russell, '89, p. 51).

Amygdaloid minerals of (Jackson, '59*a*).

As a building stone (Egleston, '86, p. 666).

Brief account of (Cooper, '22, pp. 239–243. Emmons, '52, p. 146. Emmons, '57, pp. 149–151. Marcou, '58, p. 70).

Dikes of (Macfarlane, '79, pp. 42–43).

Brief description of (H. D. Rogers, '56, p. 32).

Brief sketch of (H. D. Rogers, '58, vol. 2, p. 763).

Chemical alteration of (Hawes, '75).

Columnar structure of, discussed (E. Hitchcock, '35, p. 432).

Compiled account of (Cleaveland, '22, pp. 746–747).

Composition of (W. M. Davis, '83, p. 284. Gesner, '36, p. 169. Lesley, '83, p. 193).

Condensed account of (H. D. Rogers, '58, vol. 2, p. 671).

Considered as a metamorphosed sedimentary bed (W. M. Davis, '83, p. 280).

Contact metamorphism produced by (E. Hitchcock, '35, pp. 433–434).

Description of (J. D. Dana, '75, pp. 417–420).

Dikes of (Macfarlane, '79, pp. 42–43).

Dikes of, not confined to the Newark (Lesley, '83, p. 192).

Effects of, on sandstones, various authors cited on (W. M. Davis, '83, pp. 300–302).

Evidence of the extrusive character of certain sheets of (W. M. Davis, '82*a*, pp. 120–124).

Example of the lamination of (Lesley, '56, p. 162).

Examples of ridges of (J. D. Dana, '75, pp. 417–419).

Exposed by denudation (Lyell, '47, p. 273).

Extrusive sheets of, means of distinguishing (Davis and Whittle, '89, pp. 100–104).

Formed by the alteration of earthy sediments (Frazer, '76*b*).

General account of (M'Clure, '22).

Trap—Continued.
General account of the distribution of (G. P. Merrill, '89, pp. 433-434).
General characteristics of (Cook, '79, p. 20).
General distribution of dikes (Kerr, '75a).
Hypothesis in reference to the origin of dikes (J. D. Dana, '47, pp. 99-100).
Ideal section of sheets of, after I. C. Russell (W. M. Davis, '83, p. 281, pl. 9).
Influence of, on strike and dip of associated beds (W. B. Rogers, '42).
Intrusion of, among sedimentary beds, discussed (E. Hitchcock, '35, p. 432).
Intrusive character of (Cook, '82, pp. 14-15).
Opinions of various geologists cited on (W. M. Davis, '83, p. 279).
Intrusive sheets of, means of distinguishing (Davis and Whittle, '89, pp. 100-104).
Law of distribution of dikes of (Frazer, '76, p. 95).
Means of distinguishing extrusive and intrusive sheets (Davis and Whittle, '89, pp. 100-104).
Mechanical effects produced by the intrusion of, among stratified rocks (E. Hitchcock, '35, p. 432).
Microscopical examination of (E. S. Dana, '75).
Mineralogical character of (Mahan, '71, p. 3).
Mineralogical composition of (Hawes, '82).
Not confined to the Newark (Lesley, '83, p. 193).
Origin and character of (Cook, '79, p. 32).
Origin of (J. D. Dana, '56, pp. 322-323. J. D. Dana, '73, vol. 6, p. 108).
Discussed (J. Hall, '55-'59, p. 79. E. Hitchcock, '23, vol. 6, p. 59. Mather, '43, p. 283).
Origin of columnar form (Iddings, '86).
Origin of name (Gesner, '36, p. 169).
Origin of secondary minerals in (J. D. Dana, '45).
Trap in Alabama. Dikes in crystalline rocks (Bradley, '76. E. A. Smith, '83, p. 556).
Trap in Connecticut. About New Haven, description of (J. D. Dana, '71, pp. 46-47).
Age of, discussed (Hovey, '89).
Arrangement of dikes in the crystalline area of (Percival, '42, p. 320).
At New Haven, description of (J. D. Dana, '71, pp. 46-47).
Garnets in (E. S. Dana, '77).
At Rocky Hill, description of (Silliman, '30, pp. 124-130).
Junction of, with sandstone beneath (Silliman, '30, pp. 122-131).
At Tariffville, extrusive, with breccia (Rice, '86).
At Trumbull, description of trap dikes in Primary rocks (Percival, '42, pp. 416-417).
At Wallingford, dikes (Chapin, '35).
At West Rock, account of (Silliman, '20a, pp. 202-203).
At Woodbury, account of (Silliman, '20a, pp. 231-233).
At Woodbury-Southbury area (Whelpley, '45, p. 62).
Trap in Connecticut—Continued.
Brief account of dikes in crystalline rocks (Percival, '42, pp. 308-310).
Brief account of the distribution of (Percival, '42, pp. 10-11).
Brief discussion of (Percival, '42, pp. 310-311).
Character of (Percival, '42, pp. 312, 426).
Contact metamorphism associated with (Hovey, '89, pp. 369-375).
Contact phenomena of accompanying dikes in crystalline areas (Percival, '42, p. 317).
Description of breccias of (Percival, '42, p. 316).
Description of conglomerate of (Percival, '42, p. 316).
Detailed description of (Percival, '42, pp. 299-426).
Dikes in the Primary rocks, detailed description of (Percival, '42, pp. 412-426).
Structure of (Percival, '42, p. 312).
Disturbance produced by dikes (Lyell, '54, p. 12).
East Haven-Bradford region (Hovey, '89).
Erosion indicated by (Russell, '80a).
Fair Haven, mention of (Hovey, '89, p. 377).
Gaylors mountain, fragments in sandstone (Davis and Whittle, '89, p. 106).
In Southbury, account of (Silliman, '20a, pp. 231-233).
Intrusive and extrusive sheets of (Davis and Whittle, '89).
Metals associated with (Percival, '42, p. 317).
Metamorphism produced by (Davis and Whittle, '89).
Microscopical examination of (Hovey, '89).
Microscopical structure of (Davis and Whittle, '89, pl. 4).
Minerals of (E. S. Dana, '77).
Near Kensington, mention of (Percival, '22).
Near Meriden, brief account of dikes (J. D. Dana, '70. C. H. S. Davis, '70).
Map of ridges of (W. M. Davis, '89c, p. 424).
Structure of sheets of (W. M. Davis, '89).
Note on dikes (Lyell, '47, p. 273).
Origin of, discussed (Hovey, '89).
Origin of the crescent form of ridges of (Hovey, '89, p. 379).
Outcrops of, described and mapped (Davis and Whittle, '89).
Quarries of (G. P. Merrill, '89, p. 434. Shaler, '84, p. 127).
Relation to associated rocks (Percival, '42, pp. 426-452).
Relation to sandstone, shale, etc. (Percival, '42, pp. 426-452).
Remarks on (J. D. Dana, '72).
Remarks on crescent form of (H. D. Rogers, '43c.)
Structure of ridges of (J. D. Dana, '75a, p. 502).
System of (Percival, '42, pp. 322-410).
Two classes of (Percival, '42, p. 312).
Trap in Connecticut valley. Account of (A. Smith, '32, pp. 224-227).
Age of (E. Hitchcock, '47a, p. 203).
Breccia (Rice, '86).
Brief account of (Porter, '22).

Trap in Connecticut valley—Continued.
Brief account of dikes (Danberry, '39, pp. 22, 23).
Brief account of hills of (J. D. Dana, '73, vol. 6, p. 105).
Brief description of (Russell, '78, p. 242-243).
Brief description of conglomerate of (E. Hitchcock, '44*e*, pp. 6-8).
Conglomerate (E. Hitchcock, '58, pp. 18-19).
Connection of, with dip of associated sandstone (Silliman, jr., '42).
Crescent-shaped ridges of (Silliman, '44).
Date of extrusion of (E. Hitchcock, '35, p. 513).
Described and compared with similar rocks in other strata (E. Hitchcock, '35, p. 409).
Description of (E. Hitchcock, '47*a*, pp. 199-207).
Detailed account of (W. M. Davis, '88, pp. 462-466. Davis and Loper, '91).
Detailed description of anterior ridges of (W. M. Davis, '88).
Detailed description of posterior ridges of (W. M. Davis, '88).
Distribution of (A. Smith, '32, pp. 224-227).
Elevations of ridges of (J. D. Dana, '71, pp. 46-47).
Explanation of crescent form of ridges of (W. M. Davis, '82*a*, pp. 123-124).
General account of (Chapin, '87. Davis and Loper, '91. Eaton, '20, pp. 249-256. E. Hitchcock, '58, p. 10. Silliman, '10, pp. 95-97).
General description of (E. Hitchcock, '23, vol. 6, pp. 44-80, vol. 7, pp. 1-16, 29-30).
General description of ridges of (E. Hitchcock, '41, pp. 647-650).
Geological relation of (E. Hitchcock, '23, vol. 6, p. 50.)
Intrusive origin of (J. D. Dana, '71*a*).
Intrusive sheets of (W. M. Davis, '88, pp. 463-464).
Magnetism of (E. Hitchcock, '45*a*).
Mineralogical composition of (Silliman, '14).
Minerals associated with (Silliman, '18*a*).
Mode of formation (E. Hitchcock, '58, pp. 17-20).
Mode of formation of considered (Silliman, jr., '44).
Mode of formation of tufa (E. Hitchcock, '47*a*, p. 203).
Not accountable for the dip of stratified rocks (E. Hitchcock, '53).
Observations on the origin of sheets of (W. M. Davis, '82).
Occurrence of, in strata (Jackson, '50, p. 336).
Order of arrangement of dikes (Percival, '42, p. 302).
Origin of (J. D. Dana, '73, vol. 5, p. 431).
Origin of crescentic form of ridges of (Whelpley, '45, p. 63).
Origin of, discussed (W. M. Davis, '89*b*).
Origin of ridges of, discussed (E. Hitchcock, '35, p. 513).
Origin of sheets of (W. M. Davis, '82*a*).

Trap in Connecticut valley--Continued.
Overflow sheets (W. M. Davis, '88, pp. 464-466).
Principal overflows of, indicated (W. M. Davis, '88, p. 467).
Reference to (Newberry, '88, p. 5).
Reference to ridges of (J. D. Dana, '47, pp. 391-392).
Relation of, to elevation of associated sandstone (E. Hitchcock, '58, pp. 15-17).
Relation of, to fossil footprints (E. Hitchcock, '58, pp. 19, 20).
Relation of, to other trap systems (Jackson, '45).
Relation to topography (Lyell, '54, p. 33).
Relation to the transmission of vibrations (Stodder, '57).
Remarks on the origin of (Brigham, '69, pp. 24-25).
Ridge of (Russell, '78, pp. 244-248).
Structural significance of overflow sheets (W. M. Davis, '88, p. 467).
Topography of (W. M. Davis, '86, p. 344).
Topography of ridges of (E. Hitchcock, '47*a*, pp. 201-202).
Volcanic tufa described (E. Hitchcock, '44).

Trap in Georgia. Brief account of dikes (Henderson, '85, p. 88. T. P. James, '76, p. 38 and map. Little, '78, p. 14).
Dikes in crystalline rocks (Bradley, '76).

Trap in Massachusetts. Account of amygdaloidal (E. Hitchcock, '41, pp. 644-645).
Account of columnar (E. Hitchcock, '35, pp. 399-402).
Account of conglomerate of (E. Hitchcock, '35, p. 215).
Account of porphyritic (E. Hitchcock, '41, p. 644).
Account of tufaceous (E. Hitchcock, '41, pp. 644-645, 648).
At Deerfield, lithology of (Emerson, '82, pp. 196-198).
At Greenfield, brief account of (tuff) (E. Hitchcock, '35, p. 409).
At Mount Holyoke, brief account of (E. Hitchcock, '55*a*, pp. 87-88).
  Brief account of tuff (E. Hitchcock, '35, p. 409).
  Columnar character of (Eaton, '18, p. 34).
At Mount Tom, junction of, with sandstone (E. Hitchcock, '35, p. 421).
  Tuff on east side of (E. Hitchcock, '24, pp. 245-247).
  Tuff on west side of (E. Hitchcock, '35, p. 409).
Brief account of (E. Hitchcock, '35, pp. 23-24, 31, 202, 205).
Brief account of amygdaloid (E. Hitchcock, '35, pp. 404-405).
Brief account of economic value of (E. Hitchcock, '41, pp. 152-153).
Brief account of tufaceous (E. Hitchcock, '35, p. 405).
Catalogue of specimens (E. Hitchcock, '41, pp. 819-820).

Trap in Massachusetts—Continued.
  Chemical effects of, on adjacent strata (E. Hitchcock, '41, pp. 657-659).
  Description of (E. Hitchcock, '41, pp. 640-663).
  Description of columnar (E. Hitchcock, '41, pp. 641-643).
  Description of ridges of (E. Hitchcock, '35, pp. 408-410).
  Detailed account of (E. Hitchcock, '35, pp. 399-401).
  Dips of, in associated sandstone (Walling, '78).
  Influence of, on the inclination and character of associated sedimentary beds (E. Hitchcock, '55, p. 227).
  In gneiss (E. Hitchcock, '41, pp. 648-650).
  List of specimens of (E. Hitchcock, '35, pp. 669-670).
  Lithological character of (E. Hitchcock, '41, pp. 641-643).
  Mineral contents of (E. Hitchcock, '41, pp. 660-663).
  Origin of ranges of (Emerson, '87, pp. 19-20).
  Quarries of (G. P. Merrill, '89, p. 435).
  Relation to other rocks (E. Hitchcock, '41, pp. 650-655).
  Specific gravity of (Walling, '78, pp. 191-192).
  System of, described (E. Hitchcock, '35, pp. 513-514).
  Topography of (E. Hitchcock, '35, pp. 405-410. E. Hitchcock, '41, pp. 646-650).
Trap in New Brunswick. (Bailey, '72, pp. 220-227. Bailey, Matthew, and Ells, '80, p. 23D. Gesner, '40, pp. 16, 17, 22. Gesner, '41, pp. 15, 16, 33).
  General statements concerning (Gesner, '39, pp. 12-13, 14, 15, 16, 17, 18, 46, 47, 51, 59).
  Intrusive (Bailey, Matthew, and Ells, '80, p. 23D).
  Mention of (Bailey, Matthew, and Ells, '80, note 1 on map No. 1, S. E., accompanying).
  On Grand Manan island (Bailey, '72. Bailey, Matthew, and Ells, '80, map No. 1, S. W., accompanying, and note 7 on map. Chapman, '72. Chapman, '78, p. 106. Verril, '78).
Trap in New Hampshire. Dikes (Hubbard, '50, p. 170).
Trap in New Jersey. Analyses of (Cook, '68, pp. 215-218).
  Bells mountain, described (H. D. Rogers, '40, p. 152).
  Bergen hill, analysis of (Darton, '83).
  Bored wells in (Cook, '85, pp. 122-123).
  Bowlders of, on west side of Newark area (Nason, '89, pp. 40-42).
  Brief account of dikes (Cook, '87, p. 126).
  Brief account of (Cozzens, '43, pp. 48-49).
  Brief account of (D. S. Martin, '88, pp. 8-9).
  Brief account of (Nuttall, '22, pp. 239-241).
  Brief reference to ridges of (Newberry, '88, p. 5).
  Brief remarks on the origin of (T. S. Hunt, '74).
  Columnar (Cook, '68, pp. 202-205. Cook, '84, pp. 22-28).
  Conglomerate of (Cook, '68, p. 337).
Trap in New Jersey—Continued.
  Crescent form of ridges of (W. M. Davis, '82*a*, pp. 123-124. H. D. Rogers, '43*c*).
  Crescent-shaped ridges of (Silliman, '44).
  Description of (Cook, '82, pp. 22, 43-66).
  Description of outcrops of (Cook, '82, pp. 43-66).
  Detailed account of (Darton, '90. H. D. Rogers, '36, pp. 159-170. H. D. Rogers, '40, pp. 141-158).
  Detailed description of outcrops, etc. (Cook, '68, pp. 176-194).
  Development of ridges of (Davis and Wood, '89).
  Dikes in Archean rocks (Nason, '90).
  Diluvial scratches on (Cook, '68, p. 228).
  Dip of associated sandstone (H. D. Rogers, '40, p. 121).
  Discussion of the origin of (Cook, '83, pp. 22-26).
  Distribution of, in (Cook, '82, p. 19).
  Diverse dips adjacent to (Nason, '89, p. 19).
  Division of, into northwest and southwest areas (Nason, '89, p. 34).
  Elevations of ridges of (Cook, '68, pp. 20-21).
  Ellipsoidal lines of ridges of (Cook, '82, p. 32).
  Erosion indicated by (Russell, '80*a*).
  First mountain, junction of, with sandstone (Cook, '82, pp. 50-52).
  Formation of ridges of (Russell, '78, pp. 244-246).
  General account of (Cook, '82, p. 22. Cozzens, '43, pp. 47-48. Credner, '70. Eaton, '20, pp. 249-256. Pierce, '20. H. D. Rogers, '40, pp. 114-117).
  General description of (Russell, '78, pp. 241-246).
  General dip of (Russell, '80, p. 50).
  Goat hill, alterations produced by (H. D. Rogers, '36, p. 156).
  Hudson county, described (Russell, '80, pp. 35-45).
  Hunterdon copper mine, interstratified with shale (Dickeson, '59, pp. 8, 10).
  Intrusive (Cook, '68, pp. 20, 202-205. Cook, '79, p. 33. Cook, '83, p. 166. Cook, '87, p. 127).
  Intrusive nature of (H. D. Rogers, '40, p. 145).
  Intrusive sheets of (Russell, '78*a*).
  Lithological character of (Nason, '89, p. 37).
  Lithological description of (Cook, '68, p. 207).
  Lithology of (Cook, '68, p. 207).
  Little Falls, erosion of (Cook, '82, pp. 15-16).
  Magnetite in (Cook, '68, p. 338).
  Martin's dock, description of dikes (Cook, '82, pp. 58-59, pl. 6).
  Metamorphism near, brief account of (Credner, '70).
  Metamorphism produced by (Davis and Whittle, '89).
  Minerals accompanying (Cook, '68, p. 225).
  Montville, origin of conglomerate of (Nason, '90).
  Native iron in (Cook, '74, pp. 56-57).
  Newark, in bored well (Ward, '79, p. 150).
  Newark bay (Cook, '68, p. 177).

Trap in New Jersey—Continued.
- Orange, columnar (Cook, '84, pp. 23-28).
- Orange, near, description of columnar (Iddings, '86).
- Orange, intrusive (Cook, '84, pp. 23-28).
- Orange, popular description of (Heilprin, '84).
- Origin of (W. M. Davis, '82. H. D. Rogers, '36, p. 160).
- Origin of curved form of ridges of (Cook, '87, p. 127).
- Origin of ridges of, discussed (Darton, '89).
- Origin of sheets of (Cook, '87. W. M. Davis, '82*a*).
- Palisades, general account of (Akerly, '20, pp. 27-28, 31-37, 57, 62-64).
  - Analysis of (J. D. Dana, '72).
  - Intrusive (Cook, '68, p. 200).
  - Metamorphic origin of (B. N. Martin, '70).
  - Section of (Cook, '68, p. 200).
- Paterson, near (Cook, '68, pp. 202-203).
  - Junction of, with sandstone (J. H. Hunt, '90).
  - Thickness of (Shaler, '84, p. 143).
- Preference for the name intrusive (Cook, '89, p. 12).
- Quarries of (Cook, '79, p. 25. Cook, '81, pp. 60-63. G. P. Merrill, '89, p. 435. Shaler, '84, pp. 145-146).
- Relation of ridges of, to drainage lines (Nason, '89, p. 43).
- Rocky hill, metamorphism produced by (J. D. Dana, '43, pp. 113-114).
- Sand hills (Cook and Smock, '78, p. 233).
- Soils formed from (Cook, '78, pp. 37, 39-40).
- Sourland mountain, description of (H. D. Rogers, '40, pp. 152-158).
- Successive sheets of (Darton, '90, pp. 24-25).
- Summary of conclusions concerning (Cook, '89, p. 14).
- Thickness of (Cook, '82, p. 46).
- Topography of (Cook, '68, pp. 20-21).
- Varieties of (H. D. Rogers, '40, pp. 143-145).
- Weehawken, microscopical characters of (G. P. Merrill, '84, p. 24, pl. 8).
  - Intrusive (Cook, '82, p. 45).

Trap in New York. Closter, basaltic columns in (Akerly, '20, p. 33).
- Detailed description of (Darton, '90).
- Extent of (Mather, '43, pp. 278-282).
- General account of (Eaton, '20, pp. 249-256).
- Haverstraw (Darton, '90, p. 49).
- Origin of (Mather, '43, p. 283).
- Palisades, analysis of (Newberry, '70).
  - Brief account of (Emmons, '42, pp. 16-17).
- Rockland county, brief account of (Mather, '39, pp. 116-117, 122-123. Mather, '43, p. 279).
- Staten island, brief account of (Chamberlin, '86. Cozzens, '43, p. 56. T. S. Hunt, '83, p. 173. Mather, '43, pp. 278-283).
  - Exposures of (Britton, '81, pp. 168-170, pls. 15, 16).
  - Mention of (Mather, '38).

Trap in North Carolina. Alteration of coal near dikes (Tuomey, 48, pp. 46, 68. Genth and Kerr, '81, p. 82).
- Brief account of (Emmons, '57, pp. 150, 151. Henderson, '85, p. 88. Kerr, '74. Kerr, '75. Mitchell, '42, pp. 130-134).
- Chapel hill, mention of (Willis, '86, p. 307).
- Dan river coal field (Emmons '56, p. 258. Macfarlane, '77, pp. 526-527).
- Decomposition of (Burbank, '73, pp. 151-152).
- Deep river coal field (Chance, '85, p. 59. Emmons, '52, p. 137. Wilkes, '58, pp. 7-8).
- Dikes in crystalline rocks (Bradley, '76).
- First determination of (Mitchell, 42, p. 39).
- Gulf, alteration of coal at (Tuomey, '48, pp. 103-104).
- Mitchell cited on (Lyell, '47, p. 273).
- Sanford, analysis of (Clarke, '87, p. 138).

Trap in Nova Scotia. Absence of stratification in (Emmons, '36, p. 336).
- Brief account of (Chapman, '78, pp. 110-113. Emmons, '36, p. 335. Gesner, '36, pp, 72, 73, 74, 80, 169-265. Honeyman, '85, pp. 122-124, 127. Jackson and Alger, '33, p. 284).
- Blomidon (Dawson, '78, pp. 91, 94. Gesner, '36, pp. 211, 220, 221. Dawson, '47, pp. 55-56).
  - Amygdaloidal (Gesner, '36, pp. 211, 220, 221).
  - General account of (Honeyman, '79, pp. 27-28).
  - Microscopical character of (Marsters, '90).
- Cape D'Or (Jackson and Alger, '33, p. 263).
- Cape Sharp, mode of extrusion (Dawson, '78, p. 106).
- Containing manganese (Gilpin, 85, p. 8).
- Copper associated with (How, '69, pp. 65-66).
- Description of (Dawson, '78, pp. 86-125).
- Dikes expanding into sheets (Ells, '85, p. 7E).
- General account of (Alger, '27. Dawson, '78, pp. 87-88).
- Gerrish mountain (Dawson, '78, p. 101).
- Magnetite in (How, '75, vol. 1, pp. 136-137).
- Mention of (Willimott, '84, p. 24L).
- Minas basin (Dawson, '47, pp. 53-55. Ells, '85, p. 7E).
- Mineral composition of (Dawson, '78, p. 112).
- Mode of extrusion (Dawson, '47, p. 58).
- Moore river, near (Dawson, '78, p. 103).
- Of North mountain (Dawson, '47, pp. 55-58).
- Swan creek, near (Dawson, '78, pp. 103-105).
- Trout creek, minerals near (Gesner, '36, pp. 183-184).
  - Submerged ledges, (Perley, '52, p. 159).
- Potapique river (Dawson, '78, p. 100).
- Specific gravity of (How, '75, vol. 1, p. 138).

Trap in Pennsylvania. Adams county (Frazer, '77).
  - Examination of (Frazer, '75).
  - Localities of (Frazer, '77).
  - Optical properties of (Frazer, '76, pp, 124-129).
- Analyses of (Frazer, '82, pp. 147-150. Genth, '81).
- Associated with copper and lead (Lesley, '83, pp. 193-195).
- Beller's crossing, near (Frazer, '77, pp. 267-273).

Trap in Pennsylvania—Continued.

- Brief description of (Frazer, '82, pp. 142–150. Frazer, '83, p. 219. Lewis, '85, p. 443. H. D. Rogers, '39, pp. 21–22. H. D. Rogers, '58, vol. 1, p. 214. H. D. Rogers, '58, vol. 2, pp. 671, 699. T. P. Smith, '99).
- Berks county, brief account of (d'Invilliers, '83, pp. 199–200, 203–204, 206–226).
  - Influence of, on dips (d'Invilliers, '83, p. 48).
- Bucks county, brief account of (Lesley, '85, p. xxix).
- Caernarvon township, mention of (Frazer, '80, p. 51).
- Carlisle, mention of, near (Macfarlane, '79, p. 107).
- Cashtown, near (Frazer, '77, pp. 295–299, pl. op. p. 298).
- Chester county (Frazer, '83, pp. 219, 220, 221, 233, 234, 235, 236, 237, 238, 241, 245, 246, 274, 281, 282, 285, 286, 288, 292, 298, 307).
  - Brief account of dikes (Lesley, '85, p. xxxvii).
- Collins, detailed account of dikes, near (Frazer, '80, pp. 103–104).
- Conewago hills, description of (Gibson. '20).
- Conoy township, description of (Frazer, '80, pp. 33–35).
- Cornwall iron mines, analyses of (Lesley and d'Invilliers, '84).
  - Brief account of (d'Invilliers, 86*a*, pp. 876–879).
  - Detailed account of (Lesley and d'Invilliers, '85).
  - Dikes (H. D. Rogers, '58, vol. 2, pp. 718–719).
  - Illustrations of (Lesley and d'Invilliers, '85).
- Dikes, alterations produced by (Lewis, '82).
  - Brief account of (H. D. Rogers, '58, vol. 2, pp. 674, 684).
  - Courses of (Lesley, '83, p. 194).
  - Crystalline rocks (Lesley, '83, pp. 48, 194. H. D. Rogers, '58, vol. 2, p. 699).
  - Detailed account of (H. D. Rogers, '58, vol. 1, pp. 684–692).
  - Frequency of (Lesley, '83, p. 181).
  - Review concerning (Frazer, '84).
- Dillsburg, near (Frazer, '77, pp. 222, 230–236, 317–331).
  - Associated with iron ore (Frazer, '82, p. 136).
  - Discussion concerning (Frazer, '77, pp. 267–273, 317–331).
  - Relation to iron ore (Frazer, '76*d*).
- Downington, near (Frazer, '83, p. 234).
- Dreshertown, mention of, near (C. E. Hall, '81, p. 65).
- East Cocalico township, mention of (Frazer, '80, p. 43).
- East Douglas township, mention of (Frazer, '80, p. 52).
- East Nantmeal (Frazer, '83, p. 233).
- Easttown (Frazer, '83, pp. 285, 286, 288. Lesley, '83, p. 138).
- Elizabeth copper mine, near (H. D. Rogers, '58, vol. 2, p. 707).
- Elizabeth township, brief account of (Frazer, '80, p. 40).
- Extrusive (Lesley, '83, p. 194).
- Fairfield, near (H. D. Rogers, '58, vol. 2, p. 684).

Trap in Pennsylvania—Continued.

- Falmouth, detailed account of dikes, near (Frazer, '80, pp. 103–104).
- Flying hill, interstratified with shale etc.. (d'Invilliers, '83, pp. 203–204).
- Franklin county, localities of (Frazer '77)
- General description of (Lesley, '83. pp. 192–194).
- Gettysburg, near (Frazer, '77, pp. 295–299).
  - Chemical and microscopical examination of (Frazer, '77, pp. 309–312).
  - Weathering of (Frazer, '74).
- Gulf mills, analysis of (C. E. Hall, '81, pp. 20, 133–134).
- Honey Bush (Frazer, 83, p. 246).
- Hopewell mine (Frazer, '83, pp. 235, 236).
- Lancaster county, brief account of (Frazer, '80, pp. 2, 27–31, 124, 125).
- Landis's ore bank (Frazer, '77, p. 220).
- Lebanon county, brief account of (Lesley, '85, pp. lxiv, lxviii, pl. 35).
- Marion township (C. E. Hall, '81, p. 84).
- Marsh township, brief account of (C. E. Hall, '81, pp. 74–75).
- Mechanicsville, analysis of, near (C. E. Hall, '81, pp. 20, 133–134).
  - Mention of (Frazer, '77, pp. 274–277, pl. op. p. 274).
- Metamorphism produced by (H. D. Rogers, '39, p. 22).
- Mineralogical composition of (Frazer, '76*e*, p. 146. Frazer, '82, pp. 144–147).
- Mine ridge, near (H. D. Rogers, '58, vol. 2, p. 709).
- Mode of intrusion (d'Invilliers, '83, p. 203).
- Montgomery county, description of (C. E. Hall, '81, pp. 19–23).
- Mount Holly, description of (Frazer, '77, pp. 274–277).
- New Hope, mention of (H. D. Rogers, '48. H. D. Rogers, '58, vol. 2, p. 673).
- North Chester county (Lesley, '83, p. 211).
- North Coventry (Frazer, '83, p. 220).
- Pleasant View, near (Frazer, '80, p. 48).
- Quarries of (G. P. Merrill, '89, p. 436).
- Résumé concerning (Frazer, '82, p. 172).
- St. Mary's, near (H. D. Rogers, '58, vol. 2, pp. 707, 708).
- Shelley's ore bank (Frazer, '77, p. 222).
- South Coventry (Frazer, '83, p. 221).
- South mountain, near (H. D. Rogers, '58, vol. 2, p. 690).
- Springfield township (C. E. Hall, '81, p. 80).
- Spring Garden, near (Frazer, '80, p. 67).
- Steele's pits (Frazer, '83, p. 241).
- Stony ridge (Gibson, '20).
- Tredyffsen dikes (Frazer, '83, pp. 281, 282).
- Upper Merion, brief account of (C. E. Hall, '81, p. 84).
- Valley Forge, direction of dikes, near (Lesley, '83, pp. 195–196).
- Warwick mine (Frazer, '83, pp. 234, 237, 238).
- Wellsville, near (Frazer, '77, pp. 230–236).
- West Chester, brief account of, near (Finch, '28).
- West Cocalico township, brief account of (Frazer, '80, pp. 42–43).

Trap in Pennsylvania—Continued.

- West Donegal township, description of (Frazer, '80, pp. 36–37).
- West Goshen (Frazer, '83, p. 292).
- West Nantmeal (Frazer, '83, p. 245).
- West Town (Frazer, '83, p. 298).
- Wheatley lode, dikes (H. D. Rogers, '58, vol. 2, pp. 702, 703).
- White Marsh township (C. E. Hall, '81, p. 75).
- Williamson's point, analysis of (Frazer, '78).
  - Chemical and optical study of (Frazer, '78).
  - Illustrations of thin sections of (Frazer, '80, pl. 7).
- Woodsville (Frazer, '83, p. 307).
- Yardleyville, near (Lewis, '82).
- York, analysis of, near (Frazer, '76, pp. 122–124).
  - Chemical and optical study of (Frazer, '75*a*).
- York county, brief account of (Frazer, '85, p. 404).
  - Examination of thin sections of (Frazer, '75).
  - Localities of (Frazer, '77).
  - Optical properties of (Frazer, '76, pp. 124–129).
- York Haven, mention of, near (H. D. Rogers, '58, vol. 2, pp. 677, 678).

Trap on Prince Edward island. (Dawson, '72, p. 203. Dawson and Harrington, '71, pp. 21, 22, 49. Ells, '84, pp. 11E, 18E).

- Age of (M'Kay, '66).
- On Hog island (Chapman, '76, p. 92. Chapman, '78, p. 121. Dawson, '78, p. 123. Dawson, '78*a*, pp. 29, 31).

Trap in South Carolina. Brief account of (Butler, '83. Hammond, '84, pp. 466–467. Tuomey, '48, pp. 68, 103–104, 113. Henderson, '80, p. 88).

- Description of (Tuomey, '44).
- Dikes in crystalline rocks (Bradley, '76).
- Soils resulting from (Hammond, '84, p. 497).

Trap in Vermont. Denudation indicated by (Adams, '46, pp. 160–162).

Trap in Virginia. Brief account of (Heinrich, '78, p. 244).

- Buck hill, mention of (Clifford, '88, p. 252).
- Carbon hill, natural coke near (Clifford, '87, pp. 11, 13, 14).
- Clover Hill, mention of (De la Beche, '48, p. lxvi).
- Detailed account of (W. B. Rogers, '39, pp. 81–83. W. B. Rogers, '40, pp. 64–69).
- Farmville, reference to dikes, near (Daddow and Bannan, '66, p. 402).
- Midlothian, associated with coke (Clifford, '87, pp. 11, 13–14).
- Mineralogical and chemical composition of (Campbell and Brown, '90).
- Prince William county, metamorphism produced by (W. B. Rogers, '55*c*).
- Quarries of (G. P. Merrill, '89, p. 436. Shaler, '84, p. 179).
- Richmond coal field (Lyell, '47, p. 271).
  - Influence on coal (W. B. Rogers, '54*b*).
  - Relation to coke (Daddow and Bannan, '66, p. 400. W. B. Rogers, '54*a*. W. B. Rogers, '54*b*).

Trap in Virginia—Continued.

- Richmond coal field, remarks on (Heinrich, '75).
  - Thickness of (Lyell, '47, pp. 271–272).
- Near Staunton, description of (Darton and Diller, '90).

Trap, origin of native copper associated with (Silliman and Houghton, '44).

- Overflow origin of, opinions of various geologists cited on (W. M. Davis, '83, pp. 279–280).
- Overflow origin of sheets of (W. M. Davis, '82).
- Overflows of, from submarine volcanoes (Foster, '51).
- Possible origin of ridges of (Lesley, '56, pp. 132–137).
- Quarries of (G. P. Merrill, '89, pp. 433–435)
- Relation of, to associated sandstone (W. M. Davis, '83, pp. 284–291).
  - To copper ores in sandstones (Lyell, '54, p. 33).
  - To zeolite minerals, native copper, etc., (Jackson, '56).
- Theoretical considerations concerning (Cook, '68, pp. 336–339).
- Unity of (J. D. Dana, '73, vol. 6, p. 108).
- Various authors cited on dikes of (W. M. Davis, '83, pp. 291–293).
- Various authors cited on the cause of the curved forms of certain ridges of (W. M. Davis, '83, pp. 305–307).
- Various authors cited on sheets of (W. M. Davis, '83, pp. 293–300).

Trenton, N. J. Analysis of sandstone from (Cook, '68, pp. 515, 516).

- Boundary of Newark near (Cook, '68, pp 175, 176. Cook, '89, p. 11. Lesley, '83, p. 183. H. D. Rogers, '40, p. 118. H. D. Rogers, '58, vol. 2, p. 668).
- Brief account of conglomerate near (H. D Rogers, '40, pp. 119–120).
- Building stone near (Cook, '68, pp. 510–511).
- Character of strata west of (H. D. Rogers, '58, vol. 2, p. 672).
- Conglomerate near (H. D. Rogers, '36, pp. 155, 157–158).
- Contact of the Newark with gneiss near (H. D. Rogers, '58, vol. 2, p. 668).
- Dip at (Cook, '68, pp. 196, 197. Cook, '79, p. 29. Cook, '82, p. 26. Nason, '89, p. 18. H. D. Rogers, '40, p. 120).
- Fault near (Cook, '89, p. 14).
- Fossil crustaceans found near (Nason, '89, p. 29).
- Fossil fishes found near (Nason, '89, p. 29).
- Gneiss bordering the Newark system near (Nason, '89, p. 16).
- Junction of sandstone and gneiss at (Cook, '68, p. 247).
- Sandstone near (Cook, '68, p. 208. Cook, '79, p. 24. Cook, '82, p. 20. H. D. Rogers, '40, p. 126).
- Section from, to Milford (Cook, '79, p. 28).
- Section from, to Riegelsville, N. J. (Cook, '68, p. 199, and map in portfolio).
- Small coal seam near (Nason, '89, p. 27).

Trenton, N. J.—Continued.

Unconformity at base of Newark system near (Conrad, '39). H. D. Rogers, '36, pp. 144–145).

Tribue's coal mine, Va. Notes on (Taylor, '35, p. 284).

Trimbleville, Pa. Trap dike near (Lewis, '85, p. 445).

Trimmer's mill, N. J. Trap boundary at (Cook, '68, p. 194).

Trinity college, Conn. Special account of quarry near (Davis and Whittle, '89, pp. 120–122).

Trio islands, N. S. Description of (Jackson and Alger, '33, pp. 272–275).

Trout cove, N. S. Description of (Jackson and Alger, 33, p. 232).

Trowbridge mountain, N. J. Boundary of Newark near (Cook, '68, p. 175. H. D. Rogers, '40, p. 118).

Troy, N. C. Silicified trees near (Emmons, '56, p. 284).

True vein copper mine, N. J. Boundary of First mountain trap at (Cook, '68, p. 182).

Description of (Cook, '68, p. 678).

Truro, N. S. Boundary of the Newark near (J. W. Dawson, '78, p. 99).

Brief account of Newark rocks near (Honeyman, '74, pp. 345–346).

Description of Newark rocks near (J. W. Dawson, '47, p. 51. Ells, '85, pp. 6–7E).

Dip near (Dawson, '78, p. 99).

Geology near (Dawson, '78, pp. 88–90).

Newark rocks near (Marsters, '90).

Sandstone of (Gesner, '43).

Unconformity at base of Trias near (Dawson, '78, p. 99).

Tryon, P. E. I. Silicified wood at (Dawson and Harrington, '71, p. 16).

Tuckahoe, Va. Condition of coal mines at (Clifford, '87, p. 2).

Tuckahoe coal mine, Va. Notes on (Taylor, '35, p. 284).

Thickness of coal in (W. B. Rogers, '36, p. 54).

Tumble station, N. J. Altered shale near (Cook, '68, p. 214).

Bearing of joints near (Cook, '68, p. 201).

Dip in shale near (Cook, '82, p. 27).

Dip of red shale near (Cook, '79, p. 29).

Footprints at (Cook, 79, p. 28).

Footprints on flagstone near (Nason, '89, p. 28).

Occurrence of ripple-marks, sun-cracks, raindrop impressions and footprints at (Russell 78 p. 225).

TUOMEY, M. 1844.

Report on the geological and agricultural survey of the state of South Carolina.

Columbia, S. C., pp. i–iv, 5–63.

Contains a description of trap dikes which perhaps belong to the Newark system of igneous rocks, p. 6.

TUOMEY, M. 1848.

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TUOMEY, M.—Continued.

Contains a description of the small area occupied by the Newark system. Describes also the trap dikes that traverse a large portion of the state, and the contact metamorphisms connected with them, pp. 46, 68, 103–104, 113.

Turk Eagle rock, N. J. Elevation of First mountain at (Cook, 82, p. 49).

Turkey hill, Pa. Boundary of the Newark near (Frazer, '80, p. 15).

Turner's Falls, Mass. Additional facts concerning *Otozoum moodii* from (E. Hitchcock, '55*b*).

Bituminous shale at (E. Hitchcock, '41, p. 443).

Brecciated conglomerate near, brief account of (E. Hitchcock, '35, p. 216).

Brecciated sandstone at (E. Hitchcock, '41, p. 443).

Brief account of copper near (E. Hitchcock, '41, p. 448).

Brief account of shale at (E. Hitchcock, '35, p. 217).

Character of rock at (E. Hitchcock, '41, p. 447).

Coal near (E. Hitchcock, '35, p. 231. E. Hitchcock, '41, pp. 139–140).

Conglomerate at (E. Hitchcock, '41, p. 442).

Reference to (E. Hitchcock, '35, p. 215).

Contact metamorphism near (E. Hitchcock, '35, pp. 423–424. E. Hitchcock, '41, p. 658).

Copper ore near (E. Hitchcock, '35, p. 229).

Brief account of (E. Hitchcock, '35, p. 72).

Deerfield trap range near, on the overflow origin of (W M. Davis, '82).

Description of geology near (W. M. Davis, '83, pp. 259–261)

Description of outcrop near (Emerson, '82).

Description of scenery near (E. Hitchcock, '23, vol. 7, p. 13–16).

Description of section across the Connecticut valley at (E. Hitchcock, '55.

Dip at (W. M. Davis, '83, p. 259. E. Hitchcock, '35, p. 423. E. Hitchcock, '36, p. 308. Hitchcock, '58, p. 15, 58. Walling. '78, p. 192).

In trap and sandstone at (E. Hitchcock, '35, p. 415).

Of sandstone beneath trap at (E. Hitchcock, '41, p. 653).

Unusual, at (E. Hitchcock, '35, p. 223. E. Hitchcock, '41, p. 447).

Fault at (W. M. Davis, '88, pp. 469, 471).

Footprints at (E. Hitchcock, '58, pp. 49, et seq. Lyell, '66, p. 454. Silliman and Dana, '47. Winchell, '70, p. 183).

Crustaceans from (E. Hitchcock, '65, pp. 17–18, pl. 2).

Description of (Deane, '45. Deane, '45*b*. Deane, '45*d*. Deane, '47. Deane, '49. Deane, '56. C. H. Hitchcock, '66. E. Hitchcock, '43*a*, p. 254. E. Hitchcock, '44*a*. E. Hitchcock, '48. E. Hitchcock, '56*a*. E. Hitchcock, '65).

Turner's Falls, Mass.—Continued.
- Footprints from (Deane, '61).
  - Early discovery of (E. Hitchcock, '36, p. 308).
  - General description of Deane, '44. Deane, '50).
  - In New York state cabinet (Anonymous, '54).
  - Mention of (E. Hitchcock, '55*a*, p. 186. Shaler, '85, pp. 218–219)
  - Of a quadruped (Deane, '48).
  - Reference to (Macfarlane, '79, p. 63).
- Footprints near localities of (E. Hitchcock, '41, p. 465. E. Hitchcock, '48, p. 131).
- Fossil fishes from (Emmons, '57, pp. 143, 144. E. Hitchcock, '58, pp. 145, 146).
  - Descriptions and figures of (Newberry, '88).
- Fossil insect from (E. Hitchcock, '58, p. 7).
- Fossil plants from (Emmons, '57, p. 108. E. Hitchcock, '41, p. 450).
- Impressions supposed to have been made by Myriapods from (E. Hitchcock, '56, p. 111).
- Insect larvæ from (J. D. Dana, '75, pp. 410–411).
  - Description of (Scudder, '84).
- Junction of trap and sandstone near (W. M. Davis, '83, pp. 259–261).
- Limestone in (E. Hitchcock, '35, p. 218).
- Mention of, as a fossil locality (Packard, '71).
- Raindrop impressions from, description of (Deane, '45*b*).
- Relation of trap near, to associated rocks (E. Hitchcock, '41, p. 653).
- Sandstone at (E. Hitchcock, '41, pp. 442–443).
  - Reference to (E. Hitchcock, '35, pp. 215–216).
- Section at, of Connecticut valley, after E. Hitchcock (W. M. Davis, '83, p. 280. pl. 9. E. Hitchcock, '58, pl. 3).
- Section at, showing junction of trap and sandstone (W. M. Davis, '83, pp. 305–307, pl. 10).
- Section exposed at (E. Hitchcock, '35, pp. 414–415).
- Section exposed near (E. Hitchcock, '35, p. 221).
- Section through (E. Hitchcock, '58, pp. 9, 10, pl. 3. Walling, '78, pl. op. p. 192).
- Sketch map of country about (W. M. Davis, '83, pp. 305–307, pl. 10).
- Strike at (W. M. Davis, '83, p. 259).
- Thickness of strata at (Emmons, '57, pp. 5–6).
- Trap ridges near, account of (E. Hitchcock, '35, p. 409)
- Trap ridges near, general description of (E. Hitchcock, '41, p. 648).
- View of (E. Hitchcock, '41, pl. 10).

Two Islands, N. S. Boundary of Newark system near (Ells, '85, p. 7E).
- Contact metamorphism near (Gesner, '36, p. 254).
- Description of (Gesner, '36, pp. 249–259).
- Landslide on (Dawson, '52, p. 400).
- Minerals near (Willimott, '84, p. 28L).
- Rocks of (Gesner, '36, p. 170).
- Section near (Dawson, '47, pl. 5).

TYSON, PHILIP T. **1860.**

First report of Philip Tyson, state agricultural chemist, to the house of delegates of Maryland.

[Baltimore.] Pp. 1–xl, 5–145; appendix, pp. 1–20.

Contains a brief account of the Newark rocks of Maryland, p. 41 also a description of conglomerate and sandstone used for building purposes, appendix, pp. 3, 5–6.

TYSON, S. T Analysis of trap rock from Saltonville lake, Conn. (J. D. Dana, '73, vol. 6, p. 107).

TYSON, P. E. I. Geological structure near (Bain and Dawson, '85, p. 156).

UHLER, P. R. **1879.**

[Geological formations at railway stations in Maryland and the District of Columbia.]

In an American geological railway guide, by James Macfarlane, pp. 75–177.

States that clays of probably upper Jurassic age occur at Baltimore.

Uhlerstown, Pa. Trap outcrop near (Cook, '82, p. 63).

Unconformity at base of the Newark. (W. B. and H. D. Rogers, '43*a*, p. 523. H. D. Rogers, '58, vol. 2, p. 697).
- Briefly considered (W. M. Davis, '89*a*, p. 196).
- In Connecticut (J. D. Dana, '73, vol. 5, p. 427. Jackson, '56*b*, p. 184).
  - At Springfield (Wells, '50, p. 340).
- In Massachusetts (E. Hitchcock, '35, pl. 18 in atlas).
- In New Brunswick (Bailey, '72, p. 218).
  - At Gardners creek (Matthew, '63, pp. 256, 258. Matthew, '65, p. 125).
  - At Quaco Head (Emmons, '36, p. 344. Gesner, '40, pp. 14, 15–16. Matthew, '65, p. 125. Whittle, '91).
- In North Carolina (Emmons, '56, p. 242).
- In Nova Scotia (Dawson, '78, p. 110. Ells, '85, p. 50E. H. D. Rogers, '56, p. 32).
  - Kentville, near (Dawson, '78, p. 92).
  - Moose river (Dawson. '78, p. 103).
  - Petite river (Dawson, '52, p. 399. Dawson, '78, p. 89).
  - Truro, near (Dawson, '47, p. 51).
  - Walton, near (Dawson, '78, p. 88).
- In New Jersey (Cook, '68, pp. 98, 173. Cook and Smock, '78, pp. 39, 40, 171. Macfarlane, '79, p. 68. H. D. Rogers, '36, pp. 144–145).
  - Clinton, near (Darton, '90, p. 15).
  - Milford, near (H. D. Rogers, '36, p. 147).
  - Trenton, near (Conrad, '39).
- In Pennsylvania (Lesley, '83, pp. 132, 197. H. D. Rogers, '39, pp. 17, 19. H. D. Rogers, '41, pp. 16, 39. H. D. Rogers, '58, vol. 1, pp. 92, 103. H. D. Rogers, '58, vol. 2, p. 668).
  - Berks county (d'Invilliers, '83, p. 198).
  - Emigsville, near (Frazer, '76, pp. 91–92).
  - Harrisburg (Lesley '64, p. 476)
  - Lancaster county (Lesley, '85, p. lxiv).
  - Montgomery county (C. E. Hill, '81, p. 22.)

Unconformity at base of the Newark—Continued.
Neversink station, near (d'Invilliers, '83, pp. 221-222).
Rockville (H. D. Rogers, '36, pp. 144-145).
Valley Forge (H. D. Rogers, '58, vol. 1, p. 151).
Yardleyville (H. D. Rogers, '58, vol. 2, p. 672).
York county (Frazer, '75c).
In Prince Edwards island (Bain, '87. Bain and Dawson, '85, pp. 155-156).
Localities cited (Emmons, '52, p. 146).
Mention of (Lyell, '66, p. 457).

Unconformity at top of the Newark (Fontaine, '89, pp. 58-59. McGee, '88, pp. 134-135).

Unconformity of trap and sandstone in New Jersey. Palisade trap sheet (Darton, '90, pp. 47, 48, 49, pl. 5).
In Nova Scotia (Gesner, '36, p. 263).

Underwood's iron mine near Dillsburg, Pa. Brief account of (Frazer, '76*d*).
Description of (d'Invilliers, '86, pp. 1507-1509).
Report on (Frazer, '77, pp. 207-210).

Union, Conn. Description of trap dikes in Primary rocks in (Percival, '42, p. 424).

Union coal mine, Va. Notes on (Taylor, '35, p. 284).
Note on faults in (Taylor, '35, p. 292).
Situated in an isolated basin (Heinrich, '78, p. 232).

Union county, S. C. Trap dikes in (Hammond, '84, pp. 466-497).

Union grove, N. J. Dip in conglomerate near (Cook, '82, p. 29).

Union hill, N. J. Bored well on (Ward, '79, p. 132).
Description of trap at (Darton, '90, p. 53).
Dip of conglomerate at (Cook, '79, p. 30).
Possible connection of trap rocks near (Darton, '90, p. 39).
Stratified rocks beneath the trap at (Russell, '80, pp. 37-38).

Union station, Pa. Boundary of Newark near (Frazer, '80, p. 14).

Union village, N. J. Boundary of Second mountain trap near (Cook, '68, p. 184).
Copper ores near (Cook, '68, p. 678).
Diverse dips near (Nason, '89, p. 18).

Unionville, Pa. Trap dike near (Frazer, '84, p. 693. Lewis, '85, p. 446).

Unionville, S. C. Description of trap dikes near (Tuomey, '44, p. 12).

University of North Carolina, N. C. Boundary of the Newark near (Mitchell, '42, pp. 36-130).

Upland, Pa. Trap dike near (Frazer, '84, p. 693. Lewis, '85, p. 446).

Upper Dublin, Pa. Boundary of the Newark in (C. E. Hall, '81, p. 64-65).

Upper Dublin township, Pa. Report on the geology of (C. E. Hall, '81, pp. 64-66).

Upper Economy, N. S. Breadth of Newark near (Ells, '85, p. 49E).

Upper Milford, Pa. Boundary of the Newark area of Pennsylvania near (Lea, '58, p. 92).

Upper Milford, Pa.—Continued.
Discovery of fossil saurian bones in (Lea, '53, pp. 188, 195).
Occurrence of conglomerate in (Lea, '53, p. 190).
Reptilian bones from (Lea, '51, pp. 171-172).
Reptilian remains near (H. D. Rogers, '58, vol. 2, pp. 692-693).

Upper Merion township, Pa. Report on the geology of (C. E. Hall, '81, pp. 83-87).

Upper Piermont, N. Y. Junction of trap and sandstone near (Darton, '90, p. 48).

Valley fields, N. C. Building stone near (Olmstead, '27, p. 126).

Valley Forge, Pa. Boundary of Newark near (Frazer, '83, p. 224. C. E. Hall, '81, pp. 20, 83-84. Lesley, '83, pp. 183, 185, 191. H. D. Rogers, '58, vol. 2, pp. 668, 675-676).
Contact of the Newark with Primal and Auroral rocks near (H. D. Rogers, '58, vol. 2, p. 668).
Dip at (Frazer, '83, p. 224).
Map of boundary of the Newark near (Lesley, '83, p. 177).
Map of region about (H. D. Rogers, '58, vol. 2, op. p. 674).
Mention of Newark rocks near (Lesley, '83, p. 27).
Trap dikes near (Lesley, '83, pp. 195-196).
Unconformity at base of Newark near (Lesley, '83, pp. 186-187, 188).

Valley mountain, N. J. Description of (H. D. Rogers, '36, p. 154).

VAN DYCK, F. C. Determination of native iron in trap by (Cook, '74, p. 57).

Van Derveer's mill, N. J. Boundary of Second mountain trap near (Cook, '68, p. 183).
Dip near (Cook, '68, p. 198).

VANUXEM, LARDNER. **1841.**
Report on the ornithichnites or footmarks of extinct birds in the New Red sandstone of Massachusetts and Connecticut, observed by Prof. Hitchcock, of Amherst.
See H. D. Rogers, L. Vanuxem, R. C. Taylor, E. Emmons, and T. A. Conrad, 1841.

Van Winkler station, N. J. Conglomerate near (Darton, '90, p. 17).

Vaughan's creek, N. B. Character of rocks at (Matthew, '65, pp. 123-124).

VENABLE, F. P. **1887.**
Analysis of water from the artesian well, Durham, N. C.
In Elisha Mitchell Sci. Soc. Jour., 1887, pp. 57-58.
Gives depth of well at Durham, N. C., and an analysis of the water obtained from it.

Verdrietje hook, N. Y. Section of sandstone beneath trap near (Mather, '43, pl. 5).

Vermont. Denudation in, as indicated by trap dikes (Adams, '46, p. 160).
Trap dikes in (Adams, '46, pp. 159-162).

Vernon, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 425-426).

Vernon valley, N. J. Dip in (Cook, '68, p. 196).

Verona, N. J. Boundary of First mountain trap near (Cook, '68, p. 182).
  Boundary of Second mountain trap at (Cook, '68, p. 183).
  Description of stone quarries near (Cook, '81, p. 52).
  Record of well bored at (Nason, '89*b*).

VERRILL, A. E. 1878.
  [Note on the geology of Grand Manan island, New Brunswick.]
  In Acadian Geology, 3d. ed., by J. W. Dawson. Appendix E, pp. 679–680.
  Contains an account of the rocks composing Grand Manan island and the smaller islands about it, together with conjectures in reference to the age of the rocks.

VERRILL, A. E. Cited on overflow trap sheets on Grand Manan island (W. M. Davis, '83, p. 297).

Vertebrate fossils from Connecticut. Description of (O. C. Marsh, '89).
  Remarks on discovery of (Newberry, '85).
  From Connecticut valley (Cope, '69).
  From Massachusetts (E. Hitchcock, '58, pp. 186–187).
  From New Jersey (Cope, '68. Cope, '69).
  From North Carolina (Cope, '69).
  Descriptions of (Cope, '75. Cope, '87. Osborn, '86. Osborn, '86*a*. Osborn, '87. Osborn, '87*a*).
  Remarks on (Leidy, '69, p. 410).
  From Pennsylvania. Description of (Cope, '77. Cope, '87. Lea, '53. Leidy, '76).
  Discussion of (Cope, '66. Lea, '51. Lea, '56.)
  List of (Cope, '85).
  Notice of (Harlan, '54).
  Reclassification of (Cope, '70).
  Remarks on (Cope, '69. Lea, '57. Leidy, '57. Leidy, '60).
  See also fishes, fossil; footprints.

Vincent, Pa. Trap dikes in (Lesley, '83, p. 211).

Vincent's spur, Pa. Specimens of trap from (C. E. Hall, '78, p. 27).

Virginia. Age of the Newark system of, discussed (Lesquereux, '76, p. 283. Marcou, '58, pp. 11, 13–16, 65).
  Remarks on (Newberry, '85).
  Age of the Newark system of, as indicated by fossil fishes (W. C. Redfield, '56, pp. 180–181).
  Brief account of the coal fields of (Hotchkiss, '81, p. 120).
  Brief account of Newark areas in (Emmons, '57, p. 3. Fontaine, '79, pp. 236–239. E. Hitchcock, '56. W. B. Rogers, '79, p. 180).
  Brief account of so-called copper mine at Elk Run (Jackson, '59).
  Brief discussion of the Newark rocks of, in connection with other localities (W. B. Rogers, '54).
  Brief mention of Newark areas in (Kerr, '84, pp. 630, 631).
  Brief sketch of the Newark in (H. D. Rogers, '58, vol. 2, pp. 759–765).

Virginia—Continued.
  Clover Hill coal basin, description of (Credner, '66).
  Coal deposits of, considered as shore deposits (Russell, '78, p. 254).
  Coal fields of (Macfarlane, '77).
  Coal in, brief review of (Chance, '85, pp. 18–19).
  Coal produced in 1880 (Hotchkiss, '82).
  Coal production in 1880 (Pierce, '86).
  Condensed account of Newark rocks in (J. D. Dana, '75, p. 406).
  Conglomerate at the base of the Newark, brief account of (Emmons, '57, p. 21).
  Conglomerate in, remarks on (Cornelius, '18, p. 216).
  Coke from (W. B. Rogers, '42*b*).
  Analysis of (W. R. Johnson, '42).
  Coke from Richmond coal field (Coryell, '75). W. B. Rogers, '54*a*. W. B. Rogers, '54*b*. Wurtz, '75).
  Remarks on origin of (H. D. Rogers, '58, vol. 2, p. 764).
  Coke of Chesterfield county (Raymond, '83).
  Description and discussion of the Newark in (Fontaine, '79).
  Dip of the Newark in (W. B. Rogers, '42).
  Dips in (J. D. Dana, '75, p. 419).
  Discovery of a Posidonomaya in the southwest of (W. B. Rogers, '55*b*).
  Fossil fish from Chesterfield county, mention of (De Kay, '42).
  Fossil fishes in the Richmond coal field, note on (W. C. Redfield, '38*a*).
  Fossil plants from, description and illustration of (Newberry, '88).
  Fossil plants from, description of (Bunbury, '47. Fontaine, '83. Heer, '57. W. B. Rogers, '43. Marcou, Zeiller).
  Remarks on (Stur, '88).
  Geographical and political summary of (Hotchkiss, '76).
  Geological map of a portion of (Benton, '86, pl. op. p. 261).
  List of railroad stations on the Newark system in (W. B. Rogers, '79, pp. 180–185).
  Mesozoic formation in (Heinrich, '78).
  Midlothian colliery (Heinrich, '73).
  Explosion in (Heinrich, '76).
  In 1876 (Heinrich, '76*a*).
  Newark areas in, defined (J. D. Dana, '75, pp. 404, 405).
  Quarries of sandstone (G. P. Merrill, '89, p. 461. Shaler, '84, p. 179).
  Quarries of trap rock in (Shaler, '84, p. 179).
  Report of progress of the geological survey of (W. B. Rogers, '37).
  Report of progress on the geology of (W. B. Rogers, '39).
  Report of progress of the geological survey of (W. B. Rogers, '40).
  Report on the geology of (W. B. Rogers, '36).
  Richmond coal field, age of, discussed (Emmons, '57*b*, pp. 79–80. Lyell, '57. W. B. Rogers, '42*c*. Stevens, '61. W. B. Rogers, '55*a*).
  Analysis of coal from (Clemson, '35. Johnson, '50. Williams, '85, p. 82).

Virginia—Continued.

Richmond coal field, brief account of (Ashburner, '87, pp. 352-353. Clifford, '87. Coryell, '75. Daddow and Bannan, '66, pp. 395-403. Emmons, '57, p. 11. Grammar, '18. Hotchkiss, '80. Hotchkiss, '83*a*. W. R. Johnson, '44, pp. 308-451. W. R. Johnson, '50, pp. 133-134. 155-156. Le Conte, '82, pp. 457-459. Lyell, '47. Lyell, '49, pp. 279-288. Lyell, '54, p. 12. Lyell, '66, pp. 451-452. Maclure, '09, pp. 420-421. Nuttall, '21, pp. 35-37. Pierce, '28, pp. 57-58. W. B. Rogers, '43*b*. Silliman, '42. Taylor, '48. Williams, '85, pp. 97-98).

Character and value of (Macfarlane, '77, pp. 505-515).

Description of (Taylor, '35. Wooldridge, '42).

Lignite from (W. B. Rogers, '55).

Notes on (Marcou, '49).

Production of coal in 1885 (Ashburner, '86, p. 69).

Production of coal in 1887 (Ashburner, '88, p. 361).

Structure of (Shaler, '77).

Sections, Black Heath coal pits (Clifford, '87, pl. 4. Lyell, '47, p. 266).

Carbon hill (Coryell, '75, p. 229. Heinrich, '78, pp. 260-261).

Cascade, near (W. B. Rogers, 39, pp. 77-78).

Chalk Level (W. B. Rogers, '39, p. 79).

Clover Hill (Clifford, '87, pl. 2. Fontaine, '83, p. 9. Lyell, '47, p. 271).

Cumberland county (W. B. Rogers, '39, p. 80).

Deep Run coal pits (Clifford, '87, pl. 5).

Midlothian (Chance, '85, pp. 18-19, 22. Clifford, '87, pl. 3. Heinrich, '73, p. 347. Heinrich, '76, pl. 3. Heinrich, '78, pl. 6).

Natural coke seams near (Raymond, '83).

Newark of northern Virginia described (W. B. Rogers, '40, pp. 65-69).

Reid's Bridge and Riceville, between (W. B. Rogers, '39, pp. 79-80).

Riceville (W. B. Rogers, '39, p. 79).

Richmond coal field (Emmons, '57, pp. 11-12. Daddow and Bannan, '66, pp. 396, 397, 399. Emmons, '56, p. 339. Heinrich, '78, pl. 6. Hotchkiss, '80. Le Conte, '82, p. 457. Lyell, '47, p. 263. Lyell, '49, p. 283. Lyell, '66, p. 451. W. B. Rogers, '36, pl. W. B. Rogers, '39, pl. 2. Rogers, '84, pls. 7-8. Taylor, '35, pl. 16. Taylor, '48, p. 47).

Richmond coal field. After Daddow (Le Conte, '84, p. 328).

Richmond coal field. After C. Lyell (W. M. Davis, '83, p. 281, pl. 9).

Richmond coal field, description of (Heinrich, '78, pp. 256-260, pl. 6).

Summary of results relating to the Newark system of (J. D. Dana, '75, p. 406).

Table of geological formations found in (W. B. Rogers, '80*a*).

Trap dikes and local metamorphism in Prince William county (W. B. Rogers, '55*c*).

Trap rocks in, brief account of (Emmons, '57, p. 150).

Virginia—Continued.

Trap rocks, quarries of (Shaler, '84, p. 179).

Trap rocks from, composition of (Campbell and Brown, '90).

Unconformity between the Newark and Potomac (McGee, '88, p. 134).

VOM RATH, G. 1877.

Der Kalkspath von Bergen hill, N[ew] Jersey.

In Zeitschrift für Krystallographie, vol. 1, p. 6.

Abstract in Neues Jahrbuch, 1877, pp. 940-941.

Describes crystallographically the calcite occurring in druses in the diabase of Bergen hill, N. J., with enumeration of forms observed.

Vreeland's quarry, N. J. Dip of sandstone at (Cook, '79, p. 30).

Thickness of trap at (Cook, '82, p. 55).

Wadesboro, S. C. Boundary of Newark area near (W. R. Johnson, '51, p. 5).

Breadth of Newark rocks near (Olmstead, '24, p. 12).

Brief account of sandstone quarries at (G. P. Merrill, '89, p. 456).

Dip of sandstone southeast of (Emmons, '56, p. 212).

Notice of Newark rocks near (Mitchell, '29, map op. p. 1).

Quarries of Newark sandstone at (Shaler, '84, pp. 181-182).

Sandstone near (Kerr, '75, p. 304).

Silicified trees near (Emmons, '56, p. 284).

Wake county, N. C. An account of the Newark in (Mitchell, '42, pp. 130-134).

Walcott, Conn. Description of trap dikes in Primary rocks near (Percival, '42, pp. 415-416).

WALLACE (Dr.) Analysis of natural coke from the Richmond coal field, Va. (Clifford, '87, p. 10).

WALLING, H. F. 1878.

Some indications of recent sensitiveness to unequal pressure in the earth's crust.

In Am. Assoc. Adv. Sci., Proc., vol. 27, 1879, pp. 190-197, with 2 plates.

Presents a detailed study of dips about Mount Toby, Mass., in illustration of a hypothesis concerning the sensitiveness of the earth's crust to pressure. Refers also to the dip of the sandstone in the neighborhood of trap sheets in New Jersey.

Wallingford, Conn. Copper found near (Silliman, '18).

Description of the geology near (W. M. Davis, '83, pp. 266-267).

Description of trap ridges near (Percival, '42, pp. 401-403).

Limestone associated with decomposed sandstone near (Percival, '42, p. 436).

Limestone west of (Percival, '42, pp. 316-317).

Section at, after A. B. Chapin (W. M. Davis, '83, p. 280, pl. 9).

Section from, to Mount Tom, Mass. (W. M. Davis, '83, pp. 305-307, pl. 10).

Sketch map of trap dikes at (W. M. Davis, '83, p. 309, pl. 11).

Sketch of the geology of (C. H. S. Davis, '70).

Wallingford, Conn.—Continued.
Topographic form of trap ridge near (Percival, '42, p. 304).
Trap dikes at, description of (Chapin, '35).
Trap near, character of (Percival, '42, p. 312).
Trap ridges near (Percival, '42, pp. 348, 349, 362, 366–367).

Walnut brook, N. J. Dip along (Cook, '68, p. 197).

Walnut grove, N. C. Analysis of coal from near. See Clarke, '87, p. 146.
Coal near (Williams, '85, p. 59).

Walton, N. S. Section at (Dawson, '78, p. 89).
Unconformity at base of the Newark near (Dawson, '78, p. 88).

WANNER, ATREUS. **1889.**
The discovery of fossil tracks, algæ, etc., in the Triassic of York county, Pennsylvania.
In Ann. Rep. Geol. Surv. of Pennsylvania for 1887, pp. 21–35, including nine plates.
Abstract in Am. Assoc. Adv. Sci., Proc., vol. 37, p. 186.
Records the discovery of fossil footprints, remains of plants, etc., near Goldsboro, and gives nine plates illustrating their occurrence and characteristics. Some of the footprints illustrated in the plates accompanying the paper have been identified by C. H. Hitchcock, Boston Soc. Nat. Hist., Proc., vol. 24, p. 123.

WANNER, A. Cited on fossil footprints from Pennsylvania (C. H. Hitchcock, '88, p. 123).

Wapping, Conn. Mention of the discovery of fossil bones at (Percival, '42, p. 449).

WARD, L. B. **1879.**
Bored wells in Jersey City and vicinity.
In [Annual Report on the Geology of New Jersey for 1879], pp. 130–150.
Describes localities of bored wells, together with some account of the strata passed through, and the volume and character of the water obtained. Many of the wells mentioned are in Newark rocks.

WARD, LESTER F. **1885.**
Sketch of Paleobotany.
In U. S. Geol. Surv., Fifth Ann. Rep. of the, pp. 357–452, pls. 56–58.
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Section of palisades at, after I. C. Russell (W. M. Davis, '83, p. 281, pl. 9).

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In Boston Soc. Nat. Hist., Proc., vol. 3, pp. 339-341.

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In Am. Assoc. Adv. Sci., Proc., vol. 6, 1852, pp. 275–276.
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Brief reference to sandstone at (E. Hitchcock, '35, p. 216).

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West Vincent, Pa. Boundary of Newark near (Lesley, '83, pp. 185, 191).

Wethersfield, Conn. Footprints at, early discovery of (E. Hitchcock, '36, p. 309).

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Whately, Mass. Conglomerate in (E. Hitchcock, '35, p. 214).

Occurrence of native copper at (E. Hitchcock, '44*b*).

Wheatfield mine, Pa. Conglomerate in (d'Invilliers, '83, p. 202).

Detailed account of (d'Invilliers, '83, pp. 344-350).

WHEATLEY, CHARLES M. 1861.

Remarks on the Mesozoic red sandstone of the Atlantic slope, and notice of the discovery of a bone bed therein, at Phœnixville, Pa.

In Am. Jour. Sci., 2d ser., vol. 32, pp. 41-48.

Discusses briefly the question of the geological position of the strata referred to in the title; describes the section exposed in a tunnel near Phœnixville, Pa., and gives a list with annotations of the fossil bones, plants, etc., found at the same locality.

Republished in Jones, '62, pp. 93-95, with additions.

WHEATLEY, C. M. 1861a.

Interesting discoveries of saurian and other fossil remains in the Red sandstone of eastern Pennsylvania.

In Am. Jour. Sci., 2d ser., vol. 31, p. 301.

Abstract in Neues Jahrbuch, 1863, pp. 122-123.

Records the finding of fossil bones and fossil plants at Phœnixville, Pa., and identified some of the fossils.

WHEATLEY, C. M. 1865.

[Lithographs of fossil saurian bones from Phœnixville, Pa.]

In Am. Philo. Soc., Proc., vol. 9, pp. 4-5.

Brief mention that the lithographs referred to were exhibited to the society.

WHEATLEY, CHARLES M. 1871.

Notice of the discovery of a cave in eastern Pennsylvania containing remains of post-Pliocene fossils, including those of mastodon, tapir, megalonyx, mylodon, etc.

In Am. Jour. Sci., 3d ser., vol. 1, pp. 235-237, 384-385.

Describes the contents of a cave at the junction of Auroral limestone with the Newark system near Port Kennedy, Pa., pp. 235-237).

WHEATLEY, C. M. Cited on discovery of fossil bones at Phœnixville, Pa. (Wells, '62).

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Red shale at (Lesley, '83, p. 202).

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WHELPLEY, J. D. 1845.

[Trap and sandstone of the Connecticut valley; theory of their relation.]

In Am. Assoc. Geol. and Nat., Proc., 6th meeting, pp. 61-64.

WHELPLEY, J. D.—Continued.

Discusses the crescentic figures of the trap ridges of the Connecticut valley. Considers that the Connecticut valley sandstone was deposited in its present inclined position.

WHELPLEY, J. D. Cited on contact metamorphism in New Jersey (W. M. Davis, '83, p. 301).

WHITE, CHARLES A. 1889.

The North American Mesozoic.

In Am. Assoc. Adv. Sci., Proc., vol. 38, pp. 205-226.

Discusses briefly the evidence bearing on the age of the Newark system, and its relation to associated terranes, pp. 205-207, 208.

WHITFIELD, J. E. Analysis of coal from North Carolina by. See Clarke, '87, p. 146.

WHITFIELD, ROBERT P. 1885.

Brachiopoda and lamellibranchiata of the Raritan clays and green sand marls of New Jersey.

Monograph of the United States Geological Survey, No. 9.

Washington (Interior Dept.), 4to, pp. i-xx, 1-269, pls. 1-35, and a map.

Published also by the geological survey of New Jersey.

Trenton, 1886, vol. 1, 4to pages, etc., same as above.

Accompanied by a geological map of New Jersey.

Whitehall, N. J. Conglomerate composed of gneissic pebbles near (Nason, '89, p. 21).

Footprints at (Cook, '79, p. 28. Cook, '85, pp. 95-96. Nason, '89, p. 28).

Footprints from, description of (C. H. Hitchcock, '88, pp. 124-125).

Footprints found at, list of (C. H. Hitchcock, '88, p. 122).

Isolated trap hill near (Nason, '89, p. 37).

Whitehead's dock, N. J. Indurated shale at (Cook, '82, p. 59).

White House, N. J. Dip in shale near (Cook, '79, p. 30).

Dip in shale and sandstone near (Cook, '82, p. 29).

Dip near (Cook, '68, p. 198).

Dip of sandstone altered by trap intrusion near (H. D. Rogers, '36, p. 154).

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Trap rock near, exposure of (Cook, '82, p. 64).

Whitehouse, Pa. Trap dike near, mention of (Frazer, '84, p. 693).

White House Station, N. J. Boundary of trap near (Cook, '68, p. 193).

White Marsh township, Pa. Report on the geology of (C. E. Hall, '81, pp. 74-83).

WHITNEY [J. D.]. 1849.

[Observations on the probable origin of so-called fossil raindrop impressions on sandstone.]

See Desor and Whitney, 1849.

WHITNEY, J. D. **1855.**

Notice of the geological position and character of the copper mine at Bristol, Conn.

See Silliman, jr., and Whitney, 1855.

WHITNEY, J. D. **1860.**

On the stratigraphical position of the sandstones of the Connecticut river valley.

In Ann. Sci. Discov., 1860, p. 322.

Abstract of a communication to the Am. Assoc. Adv. Sci. at the Springfield, Mass., meeting, 1859, in which the origin of the dip of the Connecticut valley sandstone was discussed. Reasons were advanced to prove that the sandstone was deposited in its present inclined position. This view was dissented from by C. H. Hitchcock.

Whitneyville, Conn. Description of trap ridges near (Percival, '42, pp. 396–397).

White Oak, Pa. Exposure of altered schist near. See Frazer, '82, p. 121.

White Oak mountains, Va. Boundary of Newark near (Heinrich, '78, p. 238. W. B. Rogers, '39, p. '75).

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Flagging stone quarries at (Shaler, '84, p. 144).
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INDEX

A.

Page.

- Acadian area of Newark system, general description 19
  - trap rocks of 72
  - structure of 80
- Agassiz, L., cited on fossil fishes of the Newark system 125
- Areas occupied by the Newark system 9–24

B.

- Bain, Francis, cited on geology and fossils of Prince Edward island 26
- Barboursville (Virginia) area of Newark system, general description 21
  - structure of 85–86
- Bathygnatus borealis of Prince Edward island 26, 30
- Batrachians and reptiles of the Newark system 54–56
- Bogan's cut, North Carolina, section at 96
- Bradley, F. H., cited on former connection of now separated Newark areas 103
- Breccias and conglomerates 32–35
- Broad-terrane hypothesis as to deposition of Newark strata 103, 104–107
- Bunbury, C. J. F., cited on fossil plants of the Newark 127

C.

- Carbon Hill, Virginia, section at 39
- Cascade, North Carolina, section near 86–87
- Central American fossil plants compared with those of the Newark system 131–133
- Chance, H. M., cited on composition of coal of the Newark system 37
  - section at Farmville, North Carolina, by 41
  - cited on coal of the Dan river area 42
- Chinese fossil plants compared with those of the Newark 131
- Clifford, W., cited on conditions of deposition of Newark strata in Virginia and North Carolina 102
- Climatic conditions during Newark time 47–53
- Clover hill, Virginia, section at 40
  - structure at 93
- Coal of the Newark system 36–43
  - analyses 37
- Coke (natural) of the Newark system 37
- Conglomerates and breccias 32–35

Page.

- Connecticut, structure of the Newark system in 80–82
- Connecticut valley, area of the Newark system, general description 20
  - trap rocks of 73
  - structure of 80–81
  - explanation of fault structure in 98–100
- Conrad, T. A., on mollusks of the Newark 60
- Cook, G. H., cited on thickness of Newark rocks in New Jersey 107
- Cope, E. D., cited on vertebrate fossils from the Newark 55, 124
- Correlation, general principles 108–116
  - of the Newark system 120–132
- Crustaceans of the Newark system 59–60
- Cycadoidea abequidensis of Prince Edward island 27, 28

D.

- Daddow, S. H., and B. Bannan, cited on coal in the Farmville area 42
- Dadoxylon Edvardianum of Prince Edward island 27, 28, 29
- Dan river (Virginia) area of Newark system, general description 22, 42
  - structure of 85, 86, 88
- Dana, E. S., cited on composition of trap rocks 67
- Dana, J. D., cited on Triassic nomenclature 19
  - cited on conditions of deposition of Newark rocks 45
  - cited on semiglacial era at close of Newark time 49
  - cited on origin of trap rocks of Connecticut valley 74
  - cited on structure of Connecticut valley area 81
  - cited on conditions in Connecticut valley during Newark time 102
  - on geological position of the Newark as determined by fossils 139
- Danville (Virginia) area of Newark system, general description 22
  - structure of 86–87
- Davis, W. M., aid by 20
  - cited on glaciation during Newark time 47
  - cited on characteristics of trap dikes 69
  - cited on trap rocks of the Connecticut valley 73
  - cited on trap sheets of New Jersey 74, 75

Page.

- Davis, W. M.—Continued.
  - cited on structure of the Newark system, 78, 79
  - cited on structure of the Connecticut valley area, 81
  - cited on structure of Southbury area, 82
  - cited on fault structure of the Newark system, 98
  - cited on conditions of deposition of Newark strata, 102
  - cited on former extent of the Newark in the Connecticut valley area, 104, 106
- Dawson, J. W., cited on distribution of Newark rocks in New Brunswick and Nova Scotia, 19
  - cited on geology of Prince Edward island, 25, 26, 27
  - cited on conditions of deposition of Newark rocks in Acadian area, 45, 101
  - cited on trap rocks of the Acadian area, 72
  - cited on structure and position of the Acadian area of the Newark system, 80, 120
- Darton, N. H., cited on trap sheets of New Jersey, 74. 73
  - cited on Newark structure, 85
- Deane, James, cited on insect footprints of the Newark system, 58
- Deposition of Newark rocks, conditions of, 45–53
- Deep river (North Carolina) area of Newark system, general description, 23
  - rocks of, 41
  - structure of, 94, 95
- Deep river mines, structure near, 92–93
- Dikes of the Newark system, 66–77
- Dikes in the southern Newark area, 76
- D'Invilliers, E. V., cited on structure of the Newark system in Pennsylvania, 84
- Dover, Virginia, coal mines at, 38

E.

- Egypt, North Carolina, section at, 41
- Ells, R. W., quoted on geology of Prince Edward island, 26
- Emerson, B. K., aid by, 20, 73
  - cited on thickness of the Newark rocks, 43
  - cited on conditions under which Newark strata were deposited, 102
- Emmons, E., cited on Deep river (North Carolina) area of Newark rocks, 23
  - cited on North Carolina stratigraphy, 32
  - cited on vertebrate remains of the Newark, 54, 55, 123, 124, 126

F.

- Farmville (Virginia) area of Newark system, 23, 40, 88–89
  - coal in, 42
  - structure of, 88–89
- Farmville, North Carolina, section at, 41
- Fault structure, origin of, 98–100
- Fishes of the Newark system, 56–58

Page.

- Fontaine, W. M., cited on Mesozoic nomenclature, 19
  - section at Clover Hill, Virginia, by, 40
  - cited on glacial origin of conglomerates of the Newark system, 47–48
  - cited on plants of the Newark system, 62–65, 127–128
  - quoted on structure of the Richmond coal field, 89–90
- Footprints of the Newark system, 61–62
- Fossils of Prince Edward island, 26–30
- Fossils of the Newark system, 123–133
- Frazer, Persifor, cited on composition of trap rocks, 67

G.

- Gabb, W. M, cited on supposed Newark mollusks, 61
- Glacial origin of the conglomerates of the Newark system discussed, 47–53

H.

- Hall, James, cited on distribution of the Newark rocks of the Acadian area, 19
- Harrington, B. J., cited on geology of Prince Edward island, 25
- Hawes, G. W., chemical analyses of trap rocks by, 68
- Heinrich, O. J., cited on Mesozoic nomenclature, 19
  - cited on coal of the Richmond coal field, 36
  - sections in Richmond coal field by, 39
  - cited on coal in the Richmond area, 42
  - on thickness of Newark rocks in the Richmond area, 43
  - cited on structure of the Richmond coal field, 90
  - cited on former connection of now separated Newark areas, 103
- Heer, Oswald, on relations of Newark plants, 126
- Hitchcock, Edward, cited on limestones of the Newark system, 35–36
  - cited on glaciation during Newark time, 47
  - cited on reptilian remains from the Newark, 55
  - on insects of the Newark system, 58
  - cited on molluskan remains of the Newark, 60
  - on footprints of the Newark system, 61–62
  - cited on fossil plants of the Newark system, 127
- Honduras fossil plants compared with those of the Newark, 131
- Hovey, E. O., on origin of trap rocks of Connecticut valley, 74
- Hubbard, O. P., cited on thickness of the Newark rocks, 43

I.

- Ichnology of the Newark system, 61–62
- Iddings. J. P., cited on composition of trap rocks, 67

Page.

- Igneous rocks of the Newark system 66–77
- Insects of the Newark system 58

J.

- James river, section along 90–91
- James river, Virginia, mines near 91
- Johnson, W. R., cited on coal of the Richmond coal field 36
- Jones, T. R., on crustaceans of the Newark system 59
  - cited on Newark crustaceans 126

K.

- Kerr, W. C., cited on Newark areas in North Carolina 24, 95
  - cited on supposed Newark glaciation 47
  - cited on former connection of now separated Newark areas in Virginia and North Carolina 103
- Knorria of Prince Edward island 28, 29
- Knowlton, F. H., on fossil plants of Prince Edward island 29
  - cited on specific identity of fossil wood from New Mexico with that found in Newark strata 121

L.

- Lea, Isaac, cited on vertebrate remains of the Newark system 54, 55, 124
  - cited on Newark mollusks 60
  - on footprints in the Newark of Pennsylvania 61–62
  - on Newark plant remains 65
  - cited on age of the Newark 123
- Le Conte, Joseph, cited on conditions of deposition of Newark rocks 46, 102
- Leidy, Joseph, cited on reptilian remains from the Newark 30, 55
  - determinations concerning Newark fossils by 123, 124
- Lesley, J. P., cited on structure of the Newark system in the New York-Virginia area 84
  - cited on former area of Newark formation 103
- Lettenkohler plants identical with those of the Richmond coal field 114–115
- Lewis, H. C., cited on Newark mollusks 60
  - cited on structure of the New York-Virginia area 84
- Literature of the Newark system 133–339
- Lithology and stratigraphy of the Newark system 32–44
- Local basin hypothesis as to deposition of the Newark strata 101–102, 104
- Lyell, Charles, cited on the Richmond coal field 89
  - cited on fossil plants of the Newark system 127

M.

- Maclure, William, cited on former extent of Newark areas 103
- Mammals of the Newark system 54
- Manakin, Virginia, coal mines at 38

Page.

- Marcou, J., cited on age of the Newark 123
- Marsh, O. C., cited on reptilian remains from the Newark 55
  - on Jurassic fossils resembling those of the Newark formation 123
- Maryland, Newark rocks in 20
- Mather, W. W., cited on the structure of the Newark system 78
- McGee, W. J., cited on place of Raritan clays 60
  - cited on relations of the Potomac and Newark formations 105, 120
- Midlothian, Virginia, section at 39
  - coal outcrops near 92

N.

- Nason, F. L., cited on crustaceans of the Newark 59
- Newark system, origin of name 15
  - synonyms of 15–18
  - areas occupied by 19–24
  - lithology and stratigraphy 32–44
  - thickness of rocks of 43–44
  - life records of 54–65
  - structure of 78–100
  - conditions of deposition of 101–107
  - former extent of 101–107
  - determinations by various authors of age of 123
  - fossils of 123–132
  - flora of, compared with that of terranes of Asia and of Central America 131
  - literature of 133–339
- Newberry, J. S., cited on conditions of deposition of Newark rocks 46–101
  - cited on plants of the Newark system 63–128
  - cited on former extent of the Newark 106
  - on identity of Newark plants with fossil plants from New Mexico 121
  - cited on age of the Newark 123
  - cited on fossil fishes of the Newark 125
  - quoted on Mesozoic flora 131–132
- New Brunswick, Newark rocks in 19
  - structure of the Newark system in 80
- Newell, F. H., cited on the Richmond coal field 89
- New Jersey, Newark rocks in 20
  - structure of the Newark system in 83, 84
- New York-Virginia area of Newark rocks 20–21
  - trap rocks of 74
  - structure of 83–85
- Norwood coal mine, Virginia, section at 38
  - structure exhibited in 91
- Nova Scotia, Newark rocks in 19
  - structure of the Newark system in 80

O.

- Old Dominion coal mines, Virginia, strata at 38

Page.

- Osborn, H. F., cited on mammal remains of the Newark 54
- Owen, Richard, cited on Bathygnatus borealis 30

P.

- Pennsylvania, Newark rocks in 20
  - structure of the Newark system in 83, 84
- Percival, J. G., cited on two Newark areas in Connecticut 102
- Plants of the Newark system 62–65
- Prince Edward island, absence of Newark rocks on 25–31
- Pumpelly, R., cited on fossil plants from China 131

R.

- Redfield, J. H., cited on fossil fishes of the Newark 125
- Redfield, W. C., name "Newark group" proposed by 15
  - cited on fossil fishes of the Newark 125
- Reptiles and batrachians of the Newark system 54–56
- Rice, Wm. N., cited on origin of trap sheet at Tariffville, Connecticut 73
- Richmond (Virginia) area of Newark system, general description 22
  - coal of 38–40
  - structure of 89–94
  - coal plants of, identical with those of the Lettenkohlen, Germany 114–115
- Rockingham, N. C., structure near 97
- Rogers, H. D., on structure of the Newark 78
- Rogers, W. B., cited on mode of deposition of Newark rocks 45
  - cited on the structure of the Newark system 78
  - on Richmond coal field 89
  - cited on former geographic connection of Newark areas 103
  - quoted on geological position of the Newark system 126–127

S.

- Sandstones, shales, and slates 35
- Scottsville (Virginia) area of Newark system 21–86
- Scudder, S. H., on insects of the Newark system 58
- Smock, John C., cited on lithology of the New York-Virginia area 83
- Southbury area of Newark rocks, Connecticut 20, 81–82
- Stratigraphy of the Newark system 32–44
- Structure of the Newark system 78–100

Page.

- Stur, D., cited on Triassic plants 63
  - quoted on identity of fossil plants from the Lettenkohlen of Germany and the Richmond coal field 114–115
  - cited on fossil plants of the Newark 128
- Synonymy of the Newark system 15–18

T.

- Taylor, R. C., on structure of the Richmond coal field 89
- Taylorsville (Virginia) area of Newark system 22
- Theirodont of Prince Edward island, Owen on 30
- Thickness of the Newark rocks 43–44
- Trap dikes, characteristics of 69
  - outside of Newark areas 70–72
- Trap rocks, mineralogical composition 66–68
  - of the Newark system 66–77
  - chemical composition 68
  - Acadian area 72
  - Connecticut valley 73
  - New York-Virginia area 74–75
  - southern areas 76
  - distribution and age of 76–77
- Trap sheets, characteristics of 69–70

V.

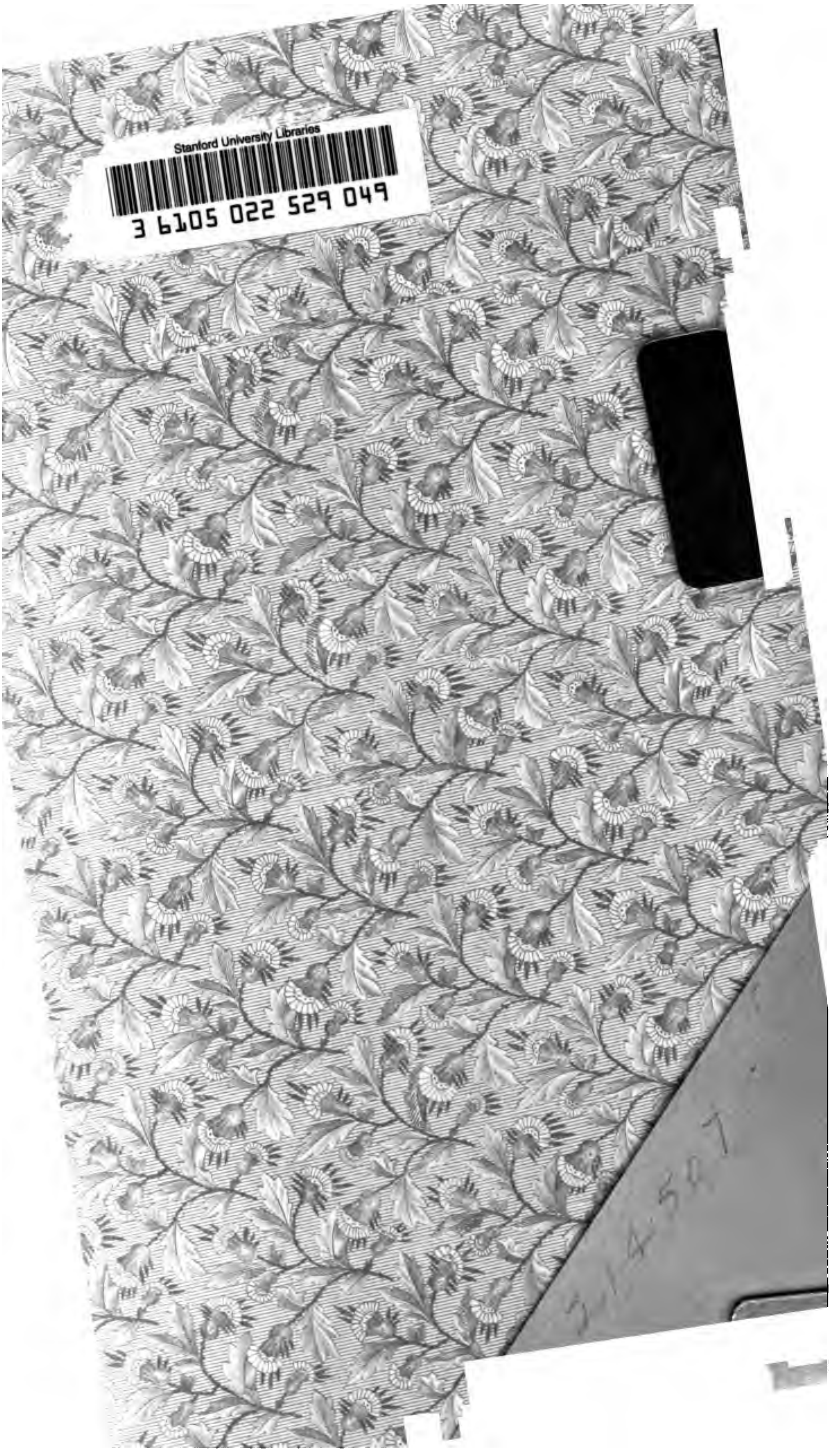
- Virginia, Newark rocks in 20, 21, 22, 23
  - Newark areas in 85–89

W.

- Wadesboro (North Carolina) area of Newark system 23–24
  - structure of 95–97
- Wanner, A., cited on footprints in the Newark of Pennsylvania 61
- Ward, L. F., cited on results of comparison of fossil plants of the Newark formation with those of the Trias of the Rocky mountain region 122
  - cited on geological position of the Newark 130
- Wheatley on crustaceans of the Newark 59
- White, C. A., on impossibility of correlating American and European formations 116
- Whitfield, R. P., on mollusks of the Newark 60
- Whitney, J. D., on structure of the Newark system 78
- Wilkes, C., cited on Deep river (N. C.) area of Newark rocks 23
  - section at Egypt, North Carolina, by 41

Z.

- Zeiller, R., cited on fossil plants of the Newark 128–129



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